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Abstracts of Principal Articles

The Production of Ball and Roller Bearings ..... P. 640

In this sixth article of a series describing the methods employed by the Hoffmann Manufacturing Co., Ltd., Chelmsford, Essex, some of the set-ups for producing ball and roller bearing cages are discussed. The department is divided into two sections, concerned with pressed and machined cages, and a total of 15,000 different types and sizes, from $\frac{1}{8}$ in. to 36 in. diameter, is handled. In the press shop, the cages are produced mainly with single-stage set-ups, but in certain instances, two-stage dial feed set-ups are employed. Standard type, 2-piece ball cage halves are produced complete, from brass strip, in a limited range of sizes, on a C.V.A. dieing press operating at 130 strokes per min., and equipped with 7-stage tools. Separators for Y-type roller cages are formed to close tolerances, with a 2-operator set-up on a 6-ton Rhodes crank press, at which a formed component is delivered every $\frac{1}{4}$ sec. In the "solids" section, cage rings are machined from bar, extruded tube, centrifugally-cast sleeves and rings, and stampings. Several machines, designed by the company, are employed for machining the ball and roller pockets. For larger rings, with either axial or radial pockets, two special-purpose Cincinnati machines have been installed. (MACHINERY, 92—21/3/58.)

Canadian System of Unit-construction for Transfer Machines ..... P. 653

A system of unit construction to facilitate the building of transfer machines, and to reduce building costs, has been developed by John Bertram & Sons Co., Ltd., Canada. Standard "block units" are employed, each of which forms, in effect, an individual machine tool, complete with its own control system. When these units are combined to form a transfer machine, they are connected by cables and plugs to a main switch panel, which provides overall control. Each block unit embodies a standard base, which may be used with wing units. Horizontal cutter heads are mounted on raising blocks on the wings, and vertical heads on columns. Each unit has its own transfer mechanism, which can be coupled to that of the adjoining unit. Elevators, pallet return conveyors and swarf-disposal equipment are provided. (MACHINERY, 92—21/3/58.)

The CEJ Mikrokator ..... P. 658

Among the wide range of metrology equipment produced by Aktiebolaget C. E. Johansson, Eskilstuna, Sweden, is the Mikrokator indicating instrument, which depends, for its operation, on the elongation, and consequent unwinding, of a thin twisted strip of phosphor bronze. This device, associated with a very light pointer of fine glass tube, forms the basis of a variety of instruments for different purposes. Some typical examples of these instruments, which include load dynamometers, extensometers, and micro-hardness testing equipment, are briefly described. The fine glass tube, from which the pointers are made, is drawn on a special rig designed and constructed by the company. Subsequently, it is further reduced manually, to obtain a taper form. Special methods and equipment are employed for cutting and trimming the 0.001-mm. duralumin foil which forms the "visible" portions of the pointers, including a fixture for accurately trimming the foil to a width of 0·2 mm. (MACHINERY, 92—21/3/58.)

Quantity Production of Nails ..... P. 667

The principal features of a large Ransohoff nail cleaning plant installed at the Castle Works, Cardiff, of Guest Keen & Nettlefolds (South Wales), Ltd., are described, and reference is made to processes involved in nail manufacture before and after the cleaning cycle. About 95 per cent of the total output of nails is processed by the Ransohoff plant. At present, more than 12 tons of nails pass through the cleaning cycle during each working hour. Nails produced at these works are sold in the United Kingdom and export markets. (MACHINERY, 92—21/3/58.)

Optically-controlled Filing Machine for Templates ..... P. 672

At the forging plant of Ford Motor Co. at Canton, Ohio, U.S.A., large numbers of templates are required, and important savings have resulted from a new system of production. With this method, the required form is laid out, on a plastics-coated sheet, known as a reticle, on a Projecto-Form scribing machine. Lines on the reticle are 0·004 in. wide, and it is subsequently employed as a master template on an optically-controlled filing machine. On this machine, the table may be moved in two directions simultaneously, to follow the outline on the reticle. (MACHINERY, 92—21/3/58.)

Cutting Internal Gear Rings on a Liebherr Hobbing Machine ..... P. 675

The German firm Hans Liebherr has been carrying out cutting operations on internal gears for more than two years, using two of their S.5 hobbing machines, with special equipment. The hob carrying slide has been replaced by a special milling head with a disc-type cutter driven through gearing and belts from an independent motor. The table of the machine is arranged for hand indexing and carries a large diameter support member for the work. Using a cutter with six solid carbide inserted teeth, 164 teeth of No. 8 Module are cut on workpieces of approximately $2\frac{3}{4}$ in. face width. The work material is a case-hardening steel, and the cycle time per tooth, for indexing, cutting and rapid return, is only 42 sec. On another machine, two workpieces are handled simultaneously. The teeth are of No. 6 Module, and approximately $4\frac{11}{16}$ total face width, and the cycle time per cut is 61 sec. To achieve these cycle times, cutting speeds of more than 1,100 ft. per min. are employed. (MACHINERY, 92—21/3/58.)

Problems of Working High Temperature-resistant Materials

An Aeronautic Production Forum was held in conjunction with the 1957 National Aeronautic Meeting of the American Society of Automotive Engineers, and two of the panels were concerned specifically with high temperature-resistant materials for use in aircraft construction, and with some of the problems involved in forming and machining such materials. In the report of one of these discussions, which was held under the leadership of Mr. J. B. Bierbower, it is pointed out that for service temperatures within the range from 600 to 1,000 deg. F. the choice of material is at present restricted to titanium and alloy steels. Considerable trouble has been experienced in providing titanium sheet with the desired flatness, thickness tolerance and surface condition, but progress is being made as a result of the introduction of new processing techniques, and it was stated that one company was planning to investigate the possibilities of heating sheet material during rolling operations in an electric resistance furnace with an argon atmosphere.

Although the difficulties associated with the rolling of stainless steel sheet are not so great, it was intimated that restrictions are at present being imposed on aircraft designers by inability of the mills to supply light-gauge materials in the lengths and widths required. To overcome existing limitations, it was suggested, it may be necessary to provide a new strip mill with motors of 12,000 to 15,000 h.p. at each stand.

Sheet thickness control was also discussed by the second panel, under Mr. R. W. Allen, and the undesirability, from the standpoint of weight, of material which appreciably exceeds the specified gauge was emphasized. Because sheet rolled from heat-resistant material tends to be thicker than the nominal value, economies can often be achieved by belt grinding over the whole surface, and with this method, thickness can be held to limits of $\pm 0{\cdot}002$ in.

For cutting shapes from heat-resistant sheet, normal routing equipment, as used for aluminium alloys, has proved unsuitable, but such equipment has been successfully modified in some instances. One company is obtaining good results with a machine which provides a spindle speed range from 2,000 to 10,000 r.p.m., and has collets which ensure minimum cutter run-out. The carbide tipped cutters must have a diameter of at least 1 in. and are cooled with carbon dioxide. Surface speeds of 800 ft. per min. for titanium and 1,600 ft. per min. for stainless steel have been found satisfactory.

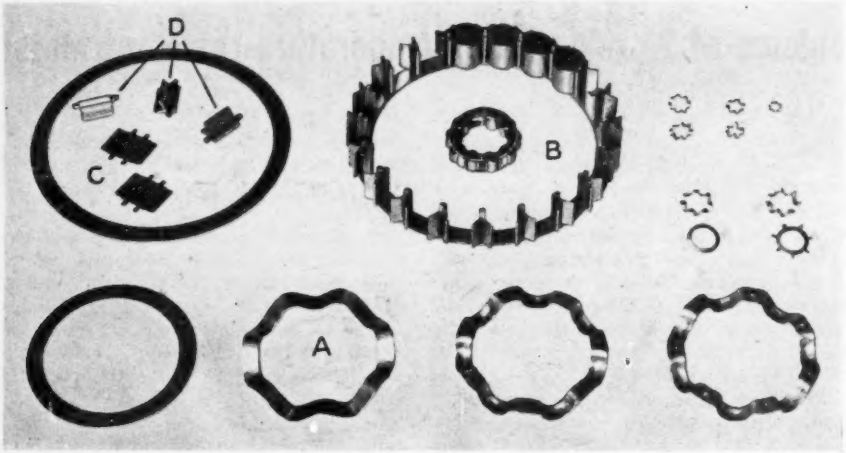
In some instances, considerable advantages are derived from heating sheet material while it is being manipulated, and the term "creep forming" has been introduced to distinguish this process. When stretch forming titanium alloy, for example, the face of the tool is maintained at a temperature of 1,000 deg. F. Under these conditions, the forces necessary for forming are reduced, and spring-back is eliminated so that a high degree of work contour accuracy can be maintained.

If parts must be made by machining rather than by working sheet stock, the production difficulties associated with the temperature-resistant materials are necessarily accentuated, and the second panel, to which reference has been made, examined certain possible solutions. In the first place, however, it was emphasized that metal removal on the scale associated with the machining of some aluminium alloy components from solid slabs could not be contemplated for the newer materials, and that plastic forming methods must be further developed and exploited.

For some machining operations on titanium and high strength heat-resistant steels, advantages may be gained from the use of throw-away ceramic inserts, but successful applications, so far, appear to be confined to finishing cuts at high surface speeds. On the other hand, it was suggested that the chemical milling process was likely to give good results on a wide variety of components. The potentialities and limitations of this process have frequently been discussed, but particular attention was drawn during the proceedings of the panel to the closeness of the limits that can be maintained in certain circumstances.

Reference was also made to the electrolytic grinding process whereby a rapid etching and lapping action are simultaneously obtained. Since the greater part of the material is removed by the electrolytic action and not by abrasion, heating and tearing of the work surface are avoided, and it is stated that, as compared with normal grinding, wheel life is often 10 or 15 times as long. The rate of metal removal obtainable is almost independent of the hardness or toughness of the work material,

(*Continued on page* 688)



The Production of Ball and Roller Bearings

Methods Employed by the Hoffmann Manufacturing Co., Ltd.

Earlier articles in MACHINERY* have been concerned with some of the methods employed by the Hoffmann Manufacturing Co., Ltd., Chelmsford, Essex, for producing bearing balls, rollers, and races. Here, some of the operations involved in cage manufacture are discussed. The cages are produced in a large department, devoted exclusively to this work, and recently centralized in a new extension to the factory. This department supplies all the cages required for the company's output of bearings, including that of a factory at Stonehouse, Gloucester, where miniature instrument-type bearings are produced. The overall range of cages comprises a total of approximately 15,000 different sizes.

The cage department is divided into "press" and "solids" sections, in which pressed and machined cages are made. In the press section, the size-range covered is ⅛ in. to 7⅞ in. diameter, and in the solids section, ½ in. to 36 in. diameter. Because of the wide range of sizes, cages are produced on a batch basis, and frequent tool changes are necessary. A high standard of accuracy is maintained throughout, and an appreciable proportion of the work comprises small batches of components of special quality, on which the tolerances are particularly close. Typical examples in the latter category include cages for aircraft engine and instrument bearings. Although, in these circumstances, a high degree of mechanization is impractical, use is made, wherever possible, of automatic or semi-automatic devices, some of which will later be described. In the solids section, there are several special purpose machines, the majority of which are so designed that each will accommodate a considerable range of sizes. Similarly, in the press section, machines covering a wide tonnage range are installed, and a very large number of press tools must be stocked and serviced.

* MACHINERY, 90/14-4/1/57; 90/680-29/3/57; 90/1256-7/6/57; 1/664-20/9/57; and 91/1012-1/11/57.

PRESSED CAGES

The pressed cages, some representative examples of which are shown in the heading illustration, are of the following four types: One-piece "snap-on"; two-piece "claw"; two-piece riveted; and "Y-type." The snap-on and claw types, which cover the instrument bearing range, are made with diameters from ⅛ in. to $\frac{7}{16}$ in. diameter. Produced from stainless steel, mild steel, and brass, the snap-on cages are of a castellated cup design, with a circular hole at the bottom of each slot. The slots are tapered, the width at the bottom being

slightly narrower than the diameter of the hole, and the intervening projections are set inwards. On assembly, these cages are sprung over the balls, which are located in the circular holes.

The two-piece claw type cages are also produced in larger sizes, from $\frac{7}{16}$ in. to $\frac{3}{4}$ in. diameter, in brass. Each such cage comprises a plain ring, with integrally formed ball pockets, and a similar ring, with narrow tabs on the periphery. When a cage of this type is assembled, the components are placed on either side of the balls, and the tabs are clinched over the edge of the plain portion. These cages are used where a two-piece pressed design is required, in sizes too small for riveting. As an indication of the standard of accuracy demanded for instrument bearing cages of the claw type, it may be mentioned that with a cage of intermediate size for $\frac{3}{32}$-in. diameter balls, the "float" is held within 0·0065/0·0095 in.

The two-piece, riveted, pressed-type cages are of the customary simple design, two identical halves, with integrally-formed ball pockets, being riveted together, with the balls between them. The term "pressed type" is used to distinguish them from the various forms of machined cages—particularly for rollers—which are also riveted. These cages are made in brass in a diameter range from $\frac{7}{8}$ in. to $3\frac{1}{2}$ in., and, in steel, from $\frac{3}{4}$ in. to $7\frac{7}{8}$ in., and are used mainly for standard ball bearings in the "popular" sizes, for which there is the greatest demand. For a typical $1\frac{1}{2}$-in. diameter brass cage in this category, for $\frac{1}{4}$-in. diameter balls, the float is 0·009/0·013 in., and the rivet hole pitch is maintained within 0·0005 in. The rivet hole diameter is held to +0·0000 in., −0·0003 in.

Brass cages of this type are produced from blanked rings of the same diameter as the finished cages, and these rings are annealed, de-scaled, and de-burred, before they are press formed and pierced for the rivets. Forming and piercing are performed as separate operations. Steel rings for such cages are blanked to a developed size, and, after they have been de-burred, are press formed to the corrugated shape seen at *A* in the heading illustration. Subsequently, the ball pockets are formed, and the rivet holes are pierced, these operations again being performed separately. The steel rings, it may be noted, are not heat treated prior to forming.

Y-TYPE CAGES

The Y-type cages, which are employed for roller bearings, are all of steel, and must be made to close tolerances. Typical examples of Y-type cages, one of which is partly dismantled to show the design, are seen at *B* in the heading illustration. As may be observed, the rollers are spaced by a series of Y-section separators mounted between a pair of side-plates. Each spacer is produced from a blank, which is folded flat, to form the "vertical" limb of the Y, and is bent outwards at each side so that the upper limbs are at an included angle of 90 deg. Some typical blanks are seen at *C*, and finished separators at *D*. Each separator is riveted to the side-plates by means of a small tab at each end, which passes through a close-fitting rectangular hole.

The Y-type cages cover a diameter range from $1\frac{13}{32}$ to $7\frac{1}{16}$ in., and for cages for rollers from $\frac{5}{16}$ in. to $\frac{15}{16}$ in. diameter, the thickness of the material for the spacers is held to limits of +0·0000 in., −0·0005 in. The limits on the blanks are as follows. Effective width (between the side plates) ±0·001 in.; length, +0·000 in., −0·001 in.; and tab width, +0·0000 in., −0·0005 in. On the formed separators, the 90-deg. angle is maintained within ±1 deg., and the bend radii of the limbs are held within ±0·0005 in. The riveting tabs are situated on those portions of the blank which subsequently comprise the "vertical" limb of the formed component, and accuracy of register is essential, since the limits on the effective width of the double thickness tabs are +0·001 in., −0·000 in. In the side plates, the nominal size of the rivet holes is maintained within +0·0000 in., −0·0002 in., and the pitch-circle diameter within +0·002 in., −0·000 in. Eccentricity of the pitch-circle diameter to the main bore is limited to a total

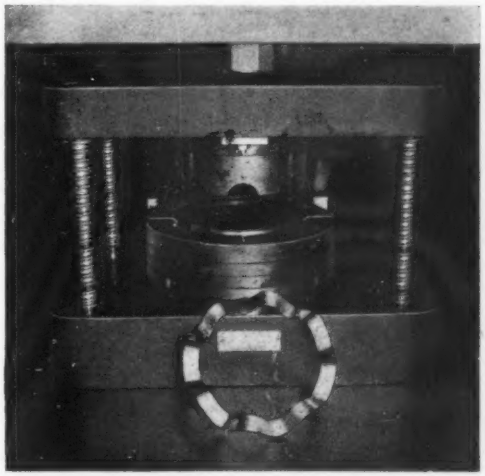


Fig. 1. Typical Press Tool, Set Up on a 500-ton Craig & Donald Press, for Forming Steel Cages from Corrugated Blanks of the Form Shown

indicator reading of 0·003 in., and the bore diameter is held within +0·001 in., −0·000 in.

PRODUCING STANDARD TWO-PIECE CAGES

Methods employed for blanking the rings for standard two-piece "pressed type" cages are, in general, orthodox. The brass blanks are annealed in Efco and Wild-Barnfield temperature-controlled electric furnaces, for 2 hours at 550 deg. C. Descaling and de-burring are performed simultaneously by the Roto-finish process, in two stages. At the first, a charge comprising 100 lb. of components, 12 cwt. of white grinding chips, No. 119 compound, and water, is barrelled for 1 hour at 8 to 15 r.p.m. This treatment is followed by honing for half an hour, with a similar charge, except that No. 266 compound is employed.

For the corresponding treatment, steel blanks are barrelled in graphite and oil, with a ballast of random sized steel bearing balls. The barrels are of an octagonal-drum type, of the firm's own design, and similar to those employed for some of the processes in ball manufacture earlier described (MACHINERY, 90/12—4/1/57). Following this stage, the oil is removed by centrifuging. The treated blanks are transferred to a stores, whence they are re-issued to the press lines in counted batches. Here, also, the requisite batch quantities of brass blanks are stacked on peg-frames, with the sharp corners downwards, to facilitate loading, in a similar manner, into the various press tools.

At the majority of set-ups in the press lines, single-stage or 2-stage tooling is employed, and except for the intermediate corrugating operation on steel cages, tools for steel and brass cages are generally similar. A typical press tool for forming the ball pockets in a corrugated steel blank is shown in Fig. 1, together with the blank. The example illustrated is for a large cage, for eight 1⅝-in. diameter balls, and the tool is set up on a 500-ton Craig & Donald crank press. In the lower tool, there is an annular recess that locates the blank by the edges, and a series of steel balls is set at the appropriate depth and spacing in the flat bottom of the recess. The punch is hollow, to fit the annular recess, and the working face is contoured to form the work against the balls and the flat surface between them.

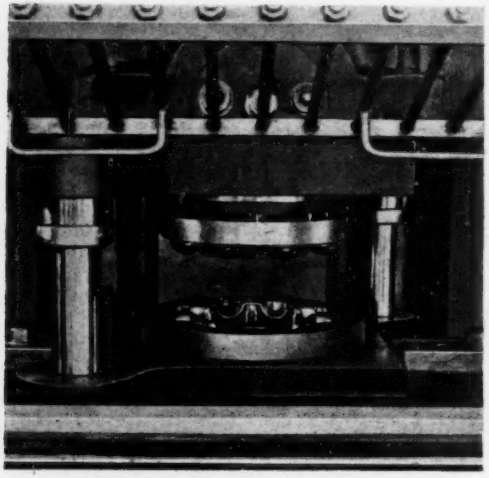


Fig. 2. Typical Rivet Hole Piercing Tools for Cages Formed at the Set-up Shown in Fig. 1

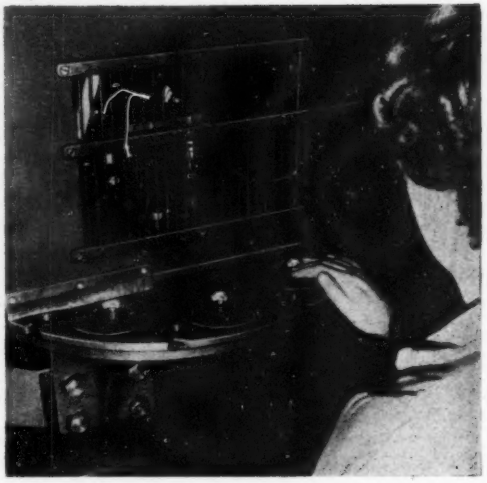


Fig. 3. At this 2-stage, Dial Feed Set-up on a Special 100-ton Taylor & Challen Press, a Formed and Pierced Steel Cage is Delivered every 4 sec.

The press tool for piercing the rivet holes in the same component are shown in Fig. 2, set up on a Rhodes 70-ton open-front geared crank press. As may be observed, the work is located by the periphery in a ring mounted on the bolster, and rests on a series of pegs which engage the flat surfaces between the ball pockets. These pegs also serve as die elements, for the corresponding piercing punches on the main punch assembly. The piercing punches are surrounded and supported by a spring-loaded stripper ring, which has steel balls projecting from the lower surface. When the press is operated, these balls enter the pockets, and thus locate the work angularly in relation to

the punches, before the latter come into operation. At this set-up, the holes are pierced 0·1885 in. diameter, +0·000 in., −0·0003 in., in a floor-to-floor time of 8 sec. per component.

Dial feed set-ups are employed for some of the smaller "pressed type" cages, and a typical example is shown in Fig. 3. The press is a 100-ton double-sided type, built by Taylor & Challen, Ltd., to a Hoffmann design. Automatic indexing of the 10-station feed dial, after each upstroke of the ram, is effected by compressed air, and the press clutch is also pneumatically operated when a pedal is depressed. The corrugated blanks are loaded into the feed-dial holes at the front of the machine, and are located by spring-loaded balls that engage the corrugations peripherally. There are two sets of tools, the first of which forms eight pockets for $\frac{13}{32}$-in. diameter balls, and the second set pierces the rivet-holes.

The first stage tool is generally similar to that seen in Fig. 1, except that the die is provided with spring-loaded ejector pins. During the upstroke of the ram, these pins return the component to the hole in the feed dial, whereby it is carried to the second station. Here, during the working stroke, the piece is located in the correct angular relationship to the piercing punches, by a spring-loaded stripper ring. This ring has a profile similar to that of the first-stage punch, and engages the ball pockets. Meanwhile, the undersides of the flat portions, between the pockets, are supported on the flat upper ends of a set of die bushes. On completion of the piercing stroke, the work is blown clear by an air jet, which propels it into the upper end of a delivery chute. At this set-up, a formed and pierced component is delivered every 4 sec.

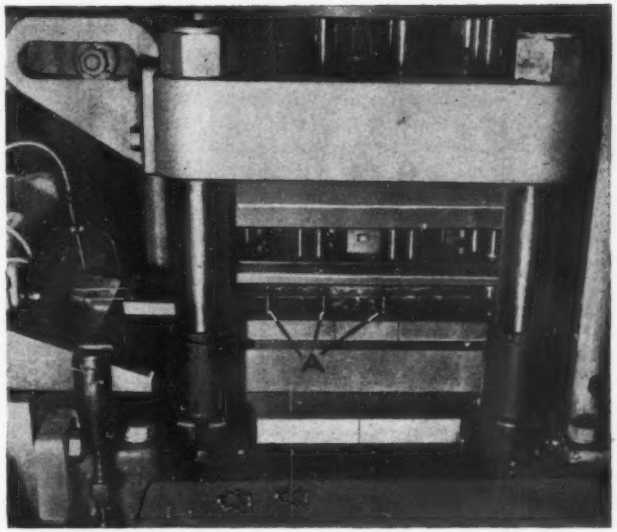


Fig. 5. Seven-stage Press Tools on a 25-ton C.V.A. Dieing Press, for Producing Complete Cages from Brass Strip, at the Rate of 130 per min.

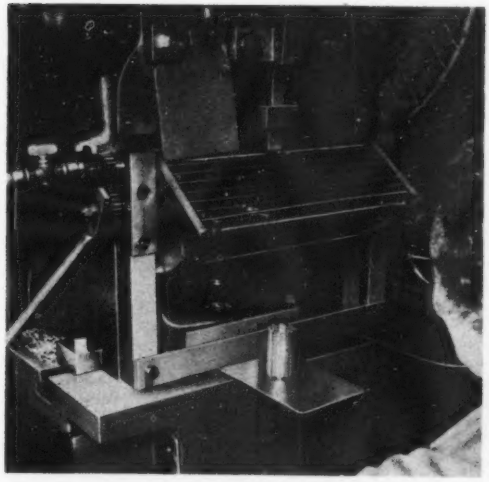


Fig. 4. Press-guards of the Type Here Shown are Fitted to a Number of 6-ton Taylor & Challen Machines. One Hand Lever Operates Both Guard and Press

Several 6-ton Taylor & Challen crank presses are employed for piercing and forming operations on some of the smaller brass cages, and they are equipped with manually-operated guards, of Hoffmann design, of the type shown in Fig. 4. The guard is actuated, through a pair of pinions, by means of the hand lever seen at the left, and the "knee" pivot at the right-hand end is coupled to a mechanical linkage. When the guard is fully lowered, this linkage trips an air valve, whereby the clutch is engaged. It is thus impossible to operate the press unless the guard is closed. The press in Fig. 4 is set up for piercing nine rivet holes, of 0·040 in. diameter, in 1⅝-in. diameter cages, in 1·5 sec. per component.

C.V.A. DIEING PRESS

A 25-ton C.V.A. dieing press is employed for producing "pressed type" cages, complete, from brass strip, in a limited range of sizes for which there is a large demand. A typical tooling set-up on this machine, for producing 1¼-in. diameter, 1-in. bore cages, with 8 pockets for ⅝-in. diameter balls, is shown in Fig. 5. The material is 0·040 in. thick, and a 7-stage tool is employed. The work performed at the various stages is indicated in Fig. 6, which shows a length of strip. Work-material is advanced by the roll feed, and at the first station, two locating holes are pierced near the edges of the strip. At the second station, these holes are engaged by pilot-pins on a profiled punch, which blanks out the surplus material between adjacent discs, and leaves the latter connected to the strip by a narrow neck on each side.

At the third stage, a locating hole is punched in the centre of the disc, and at the fourth stage, this hole is engaged by a pilot pin on a circular punch, which blanks out the centre of the disc. Between the fourth and fifth stages, there is an idle station, and at the fifth stage, the ball pockets are coined by a piloted punch. To provide for lifting the formed work out of the die, and lowering it into the bottom tools at the sixth and seventh stages, the strip is guided between three pairs of grooved pins. These pins, which may be seen at A in Fig. 5, are spring-loaded, and are depressed by the stripper plate of the punch assembly. There are also idle stations between the fifth and sixth, and the sixth and seventh stages, and, at the sixth, the rivet holes are pierced. At the final stages, the necks connecting the work to the edges of the strip are sheared, and the completed component is delivered by way of a chute. The machine is fitted with a scrap cutter, and is run at 130 strokes per min.

As already indicated, the snap-on cages for instrument type bearings are made for bearing sizes down to ⅛ in. diameter, for which the balls are of 0·020 in. diameter. The flat un-pierced blanks for cages of this type are produced by conventional methods, and, subsequently, are formed and pierced, by separate operations, on small arbor presses. A typical set-up, for the forming operation, is shown in Fig. 7. The lower tool is mounted on a slide, which is held against a stop near the front of the table by means of a tension spring, roller chain and pulley system. In this position, the lower tool is well forward of the upper, so that it is readily accessible for loading.

The blank is located by the edges in a bore

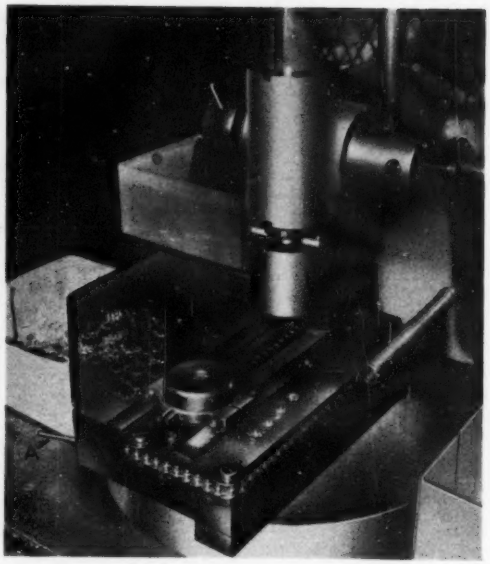


Fig. 7. Small Arbor Presses, Tooled as Shown, are Employed for Forming Snap-on Cages for Instrument Bearings

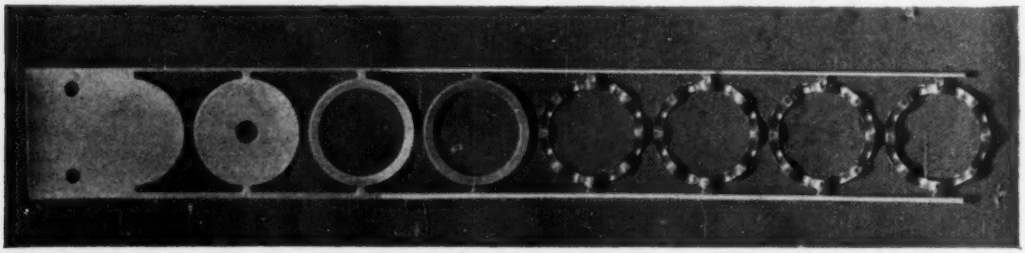


Fig. 6. A Strip Showing the Work Performed at the Various Stages of the Press Tool Seen in Fig. 5

in the lower tool body, and rests on the top of a peg, which is mounted concentrically within the bore. The top of this peg is slightly below the level of the upper face of the body. When the tool is loaded, it is moved beneath the press-ram by means of a pedal, which is connected to the rear of the slide through another length of roller chain. This chain passes over another pulley, and holds the slide against a back stop. When the press is operated, a hollow punch, with a central spring-loaded ejector pad, draws the edges of the blank downwards over the lower peg, and the slide is then permitted to return to the loading position by releasing the pedal. The formed component is ejected from the lower tool by means of the small hand lever A, which actuates a sleeve surrounding the peg. With this equipment, the components are formed in 3 sec. each. Apart from the design of the tools, the set-up for piercing the formed components is identical.

Y-TYPE SEPARATORS

The Y-type separators are formed from the blanks, to the tolerances earlier indicated, at set-ups of the type shown in Fig. 8. This illustration gives a close-up view of a 6-ton Rhodes crank-press, and a formed component is delivered every ½ sec. To enable details of the tooling to be observed, a guard which encloses the working zone has been removed. Normally, one girl operator is seated at the circular tray *A*, to the left, and another at the front of the machine, within convenient reach of the lever *B*. The operator at *A* arranges the blanks all the same way up in the tray, and inserts them all the same way round into a feed-magazine *C*. Blanks must be fed the same way up, because, at the blanking stage, they are given a slight initial set, to facilitate forming.

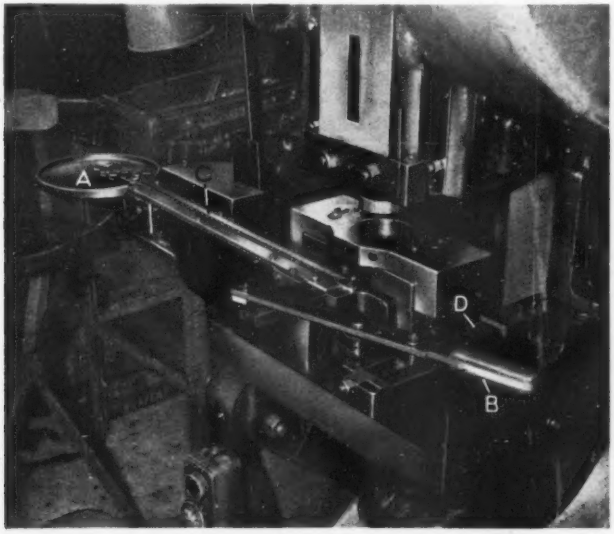


Fig. 8. This Set-up, with Two Operators, on a 6-ton Rhodes Crank Press, is Employed for Forming Y-type Separators. A Formed Component is Delivered Every ½ sec.

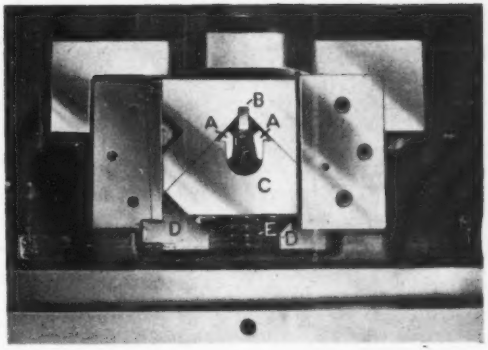


Fig. 9. Rear View of the Tool for Forming Y-type Separators

In the bottom of the magazine, there is a driven Gripolastic belt, against which the blanks are lightly held by retaining flanges. This belt urges them along towards the right, until each, in turn, meets a stop that aligns it with the press tool. As each blank reaches this point, the second operator actuates the lever *B*, which is coupled to a horizontally-sliding blade. The blank is thus slid out of the end of the magazine and into the press tool, and the press is then operated. A "gate" mechanism, also connected to the lever through the member *D*, makes it impossible to operate the press unless the blade has been fully advanced, and then withdrawn.

At each stroke of the blade, the blank is pushed along the flat bottom of a triangular-section tunnel in the body of the press tool, a rear view of which is given in Fig. 9. In this view, the tool is seen with a retaining plate removed from the left-hand

side, to allow details of the design to be observed. The tunnel serves to align the work squarely, by the edges, as it is fed through on to the tops of a pair of inclined punches *A*, and against a stop *B*. Immediately above the inclined punches, in the apex of an inverted vee formed by an extension of the tunnel into the upper portion of the tool, is mounted a 90-deg. form punch. In Fig. 9, it may be noted, this punch is concealed by the stop *B*.

The inclined punches *A* are arranged to slide in the member *C*, and are individually spring-loaded, so that their lower ends are held in contact with the cam blocks *D*. The assembly, comprising the member *C* and the inverted-vee portion, is free to move vertically on guides, and is upwardly loaded by the compression spring *E*. When the press is operated, the assembly is pushed downwards against the spring, so that the 90-deg. form punch is lowered, and, at the same time, the inclined punches *A* are moved inwards. The combined action of these three elements folds the blank along the centre line, clinches the fold, and sets the limbs to the required angle, against the 90-deg. form punch. When the press ram is raised, the formed component is released, and is ejected through a curved guide-channel machined in the member *C*. It may be pointed out that, in order to maintain the limits on the formed components, earlier indicated, considerable care is necessary in setting-up and maintaining these tools.

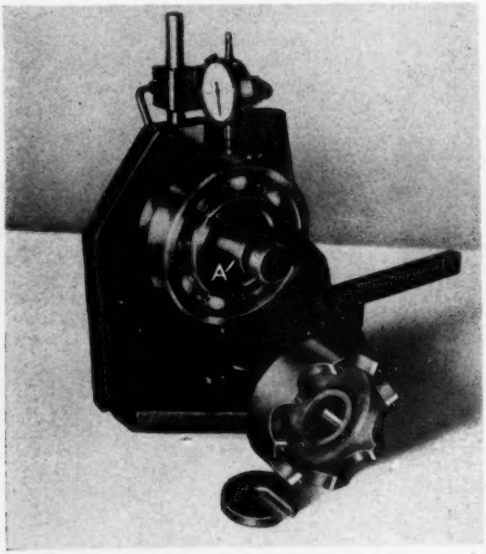


Fig. 10. Typical Fixture for Checking Ball Cage "Float." The Cage is Located by the Flat Portions Between the Ball Pockets

CHECKING AND INSPECTION

The accuracy of the press tool settings, at the various set-ups employed, is checked whenever the tools are changed in readiness for a fresh batch. The settings are also checked periodically, during the batch run, by patrolling inspectors. For this purpose, there is a small inspection section associated with the press shop, where the components are checked on equipment of the type shown in Fig. 10. Although the example illustrated is for checking two-piece standard "pressed type" ball cages, the method employed is basically the same for most types. A pair of cage halves is assembled with a set of standard balls and races, and is clamped between a pair of rings, one of which is seen in front of the fixture. One of these rings is mounted on a spigoted register attached to the fixture body, and the other is passed over the mandrel *A*, which is grooved for a C-washer. Clamping is effected by tightening a screw on the opposite end of the mandrel.

As may be observed, the faces of the rings are relieved to clear the ball pockets, so that the work is engaged only by the flat portions between them. Locating pins are inserted through the rivet holes, and are engaged by corresponding holes in the rings. The assembly is thus supported entirely by the cage. A dial gauge is mounted with the contact stem in engagement with the top of the outer race, and the latter is raised and lowered by means of a lever. In this way, the effective "float" of the cage is indicated directly on the dial gauge. Several fixtures of this type are used, in order to cover the overall size range, and each fixture is designed to accommodate various sizes of cages, by the use of interchangeable clamping rings and spigoted registers. The example illustrated will accommodate cages of 3 in. to 8 in. diameter. With the smaller clamping rings, for example, for the "claw-type" cages, locating pins are not provided.

All finished brass cages are again barrelled by the Roto-finish method, after which they are visually inspected. At the same time, the standard two-piece "pressed type" cages are checked for accuracy of rivet hole spacing. For this purpose, they are placed in stacks of two or three dozen, and a pin is inserted through one of the holes, right through the stack. The alignment of the other holes is then checked by pushing another pin through them, at two or three random positions, at each of which it must enter freely.

MACHINED CAGES

As earlier mentioned, the overall size range covered in the "solids" section is ½ in. to 36 in. diameter, and the components are mainly of brass and bronze, but occasionally of steel. In sizes from ½ in. to 5⅝ in. diameter, a proportion of the brass cage rings for ball and roller bearings are produced from bar, and some are also machined from tube, in sizes from 1½ in. to 3¾ in. diameter. Short extruded sleeves are used for sizes of 3½ in. to 5⅝ in. diameter, and larger sizes, up to the maximum, are machined from centrifugally-cast short sleeves, or yellow metal stampings. Much of the work undertaken involves very close tolerances, and in a number of instances, an exceptionally high standard of surface finish must be maintained. For example, on certain gyro instrument bearings, the surface finish must be within 12 micro-inches.

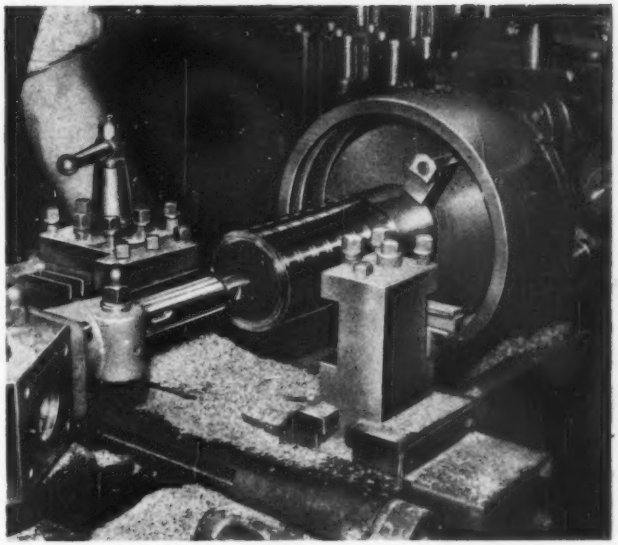


Fig. 11. Certain Sizes of Cage Rings are Trepanned from Bar on Herbert No. 4 Capstan Lathes, as Here Shown

A wide variety of machines is employed for the different classes of work. For example, B.S.A. single-spindle automatics are used for bar work of ½ in. to 2 in. diameter, for which the typical cycle times range from 12 sec. to 1 min. A limited number of sizes over 2 in. diameter, up to the maximum indicated, are machined from bar on Herbert No. 4 capstan lathes. A large number of Hoffmann special-purpose automatic machines is employed, also for a proportion of bar work, down to ½ in. diameter. At a typical set-up, rings are machined to 2·9962/2·9990 in. bore diameter, 3·542/3·554 in. external diameter, and 0·484/0·486 in. wide, from 3·593-in. external diameter tube, in a cycle time of 37 sec.

The short, centrifugally-cast sleeves are mainly machined on Herbert No. 4 Senior Eloptive lathes, and, in order to avoid distortion, the following procedure is employed. Each sleeve of a batch is first set up in a 3- or 4-jaw chuck, and the outer end is turned to the finished diameter, over a width corresponding to that of one ring. A split ring is next placed in the lathe-chuck and serves to hold the work by the portion previously machined. Each sleeve is then rough and finish turned on the external diameter, and rough bored, and the rings are faced and parted-off to length. In this way, out-of-roundness is held within 0·003 in.

Over a limited range of sizes, some of the larger cages produced from bar are machined by a trepanning technique, and a typical set-up for this purpose, on a Herbert No. 4 capstan lathe, is shown in Fig. 11. The brass bar is 4¼ in. diameter, and from a length such as that seen in position, 11 rings $\frac{5}{16}$ in. wide, and an equal number 0·138 in. wide, are produced. These rings have an external diameter of 4·159 in., and a bore-diameter of 3·827 in., and are intended for use in pairs, each comprising one narrow and one wide ring, for roller cages. For cages of this type, the narrow ring is subsequently recessed to fit a corresponding spigot machined on the wider ring. In the assembled bearing, the narrow ring serves to retain the rollers in the cylindrical pockets, which are machined axially in the wider ring.

At the set-up described, the work is run at 620 r.p.m., and the outer end is first centred, and engaged by a centre on the turret. The diameter is rough turned with a Wimet N carbide tipped tool in the front tool-post, with a feed of 0·013 in. per rev., and a tool mounted in the rear tool-post is applied to face the outer end. Next, the work is grooved, with a pair of tools set $\frac{5}{16}$-in. apart, at intervals such that the $\frac{5}{16}$-in. and 0·138-in. widths, between the grooves, alternate along the length of the bar. These tools are of high-speed steel, and are fed in by hand to a depth corresponding to the wall thickness of the finished rings.

After a finishing cut, which removes 0·02 in.

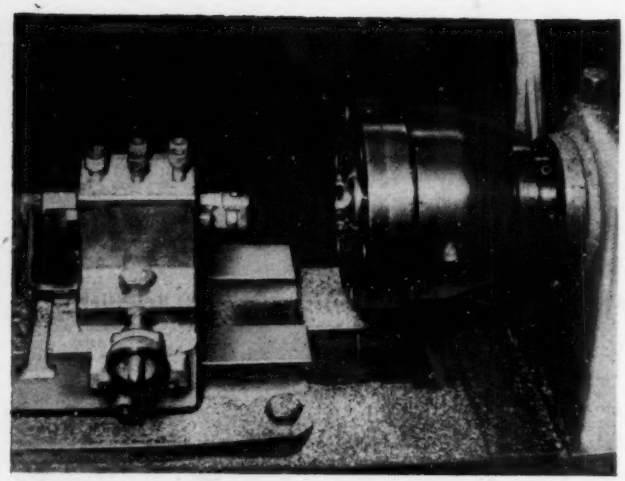


Fig. 12. At This Typical Set-up on an Atlas Second-operation Lathe, a Brass Cage Ring is Bored, Spigoted and Chamfered in a Floor-to-floor Time of 10 sec.

from the diameter, the rings are parted from the bar by feeding in, from the outer end, a high-speed steel trepanning tool mounted in the front tool-post. This stage is seen in progress in Fig. 11. As each ring is parted off, the tool is withdrawn, the ring is moved back over the centre support, and the tool again advanced. This procedure is repeated until all the rings have been parted, leaving a core bar of usable-material. At the set-up described, the floor-to-floor time per pair of rings is 2·15 min.

SECOND-OPERATION LATHES

Supplementary operations on the rings produced by the various methods described, such as chamfering, boring, finishing to width, recessing, and spigot turning, are performed on a line of Atlas second-operation lathes. A typical set-up on one of these machines is shown in Fig. 12. The work is held in a lever-operated collet, and is run at 1,080 r.p.m. It is bored to 1·679/1·682 in. diameter, and a spigot, of 1·741/1·742 in. diameter by 0·0287 in. long, is formed on the end face, so that the width, at the external diameter, is reduced to 0·4703/0·4723 in. At the same time, the sharp external corners are removed. These operations are all performed at a single pass, with a set of tools mounted on the hand operated longitudinal slide. A Wimet N carbide-tipped tool is employed for boring, and a form-tool machines the spigot and the two adjacent end faces. Chamfering is performed by means of a vee-shaped tool, mounted above the form tool. The stage is completed on each ring in a floor-to-floor time of 10 sec. Corresponding operations on rings of sizes beyond the capacity of the Atlas lathes, are carried out by conventional turning methods.

DRILLING

After the second-operation stage, the rings for two-piece cages are passed to a drilling section, where the holes for the rivet pins are drilled. In cages of this type, it may be noted, these holes are drilled before the pockets are machined. The equipment of this section includes several Boley multi-spindle machines, which are used for all work for which the number of spindles,

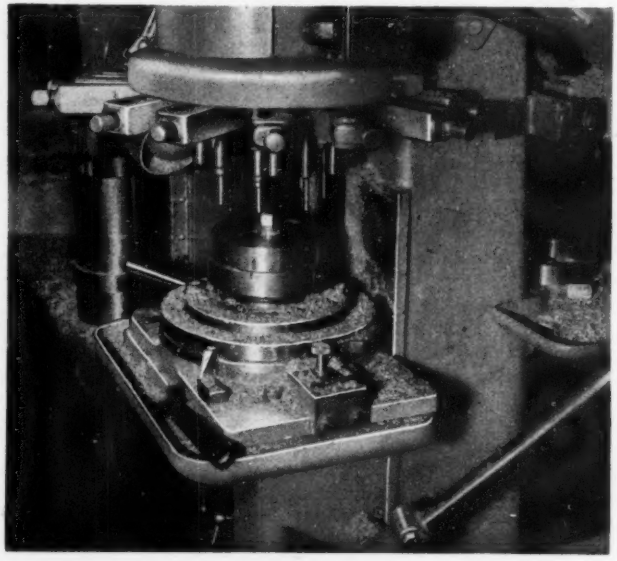


Fig. 13. Boley Multi-spindle Drilling Machines are Extensively Employed for Drilling the Rivet Holes

and the overall pitch-circle capacity, are suitable. An interesting feature of the set-ups on these machines is that, although the drills are small, satisfactory results are obtained without the use of steady bushes. The machines are equipped with special spindles and bearings, made and fitted by the company, and the drills are ground to an included angle of 65 deg. Limits of ±0·005 in. are maintained on hole spacing, and of −0·000 +0·001 in. on hole diameter. Loading and unloading are facilitated by the absence of bush plates.

A typical set-up on one of these machines, for drilling 14 holes of 0·0935 in. diameter in the cap and body of a two-piece roller cage, is shown in Fig. 13. Seven spindles are employed, and the cap and body are drilled simultaneously in two stages. The cap is fitted to the register on the body, and the two components are placed on an expanding mandrel. This mandrel is mounted on a simple 2-position indexing base, and is expanded by means of a central screw. The spindles are run at 2,000 r.p.m., and the work is drilled by raising the table by means of the hand lever at the lower right-hand side in Fig. 13, at each index position. The depth of the holes is ⅞ in., and this stage is completed on each pair of components in a floor-to-floor time of 45 sec. Cages too large to be handled on the multi-spindle machine, are drilled on single-spindle machines.

Before the 2-piece cages are removed from the drilling machines, a mark is scribed down one side of both components. At subsequent machining and assembly stages, these marks are aligned in order to ensure that the rivet holes in the two portions are correctly registered, in the relationship in which they were drilled. Two-piece ball cages, for example, are temporarily pinned together for the pocket machining operation, with the holes aligned in this manner. The drilled components are de-burred on small Hoffmann special-purpose 2-spindle machines. The spindles are vertical, and their upper ends project into an open-fronted housing equipped with air extraction trunking. One spindle is fitted with a flexible abrasive disc, and the other with a flat, face-type wire brush. Both ends of each temporarily-assembled pair of components are first lightly smoothed on the abrasive disc, and are wire brushed. In this way, each pair is de-burred in 10 sec.

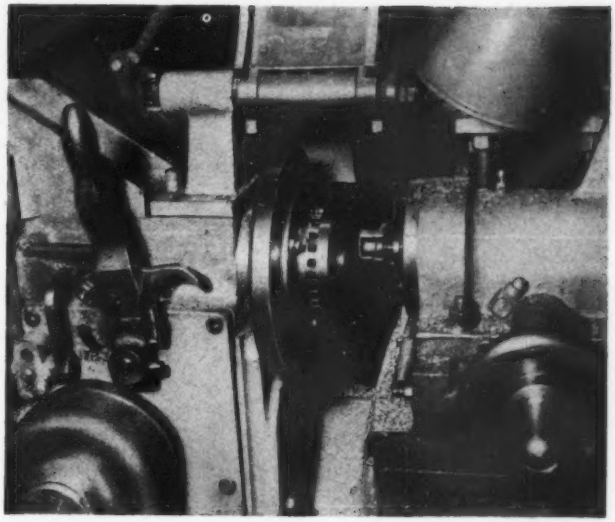


Fig. 14. At this Set-up, on a Hoffmann/Meadows Special-purpose Machine, 22 Axial Roller Pockets are Machined in a Floor-to-floor Time of 1 min.

MACHINING THE POCKETS

A large, comprehensively-equipped, section of the cage machine shop is devoted to operations on ball and roller pockets, and the equipment employed falls, broadly, into two categories, for cages in which the pockets are machined axially and radially. In the majority of the roller cages, the pockets are machined axially, although there are certain exceptions, as will later be discussed. The ball cages are predominantly of the radially-machined type, although here again, there are exceptions. Among the latter may be mentioned certain double-row cages, for self-aligning bearings. Practically all the cages in the company's standard range are machined with spade-type high-speed steel cutters.

The various machines are grouped according to type, and one group comprises several special-purpose axial machines of the firm's own design, built by Henry Meadows, Ltd. Fully automatic, these machines are employed for roller pockets of ¼ in. to 1 in. diameter, and certain ball pockets. A typical set-up on one of these machines is shown in Fig. 14, at which 22 roller pockets, of ½ in. diameter by ½ in. deep, are machined in a brass cage-ring in a floor-to-floor time of 1 min. Limits of +0·001 in. −0·000 in. are maintained on the diameter, and ±0·002 in. for spacing. The work

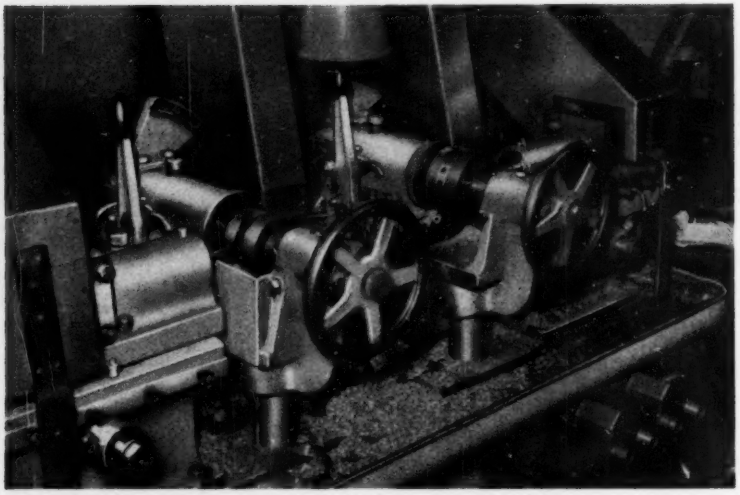


Fig. 15. Special-purpose Hoffmann 2-spindle Machines, of the Type Here Shown, are Extensively Employed for Machining Radial Pockets in Medium-sized Cage Rings

is clamped to a register spigot mounted on a face-plate, on which it is located angularly by the rivet holes. Clamping is effected by means of a drilled circular plate, with a radial slot similar to that of a C-washer, which is engaged with a groove in the end of a drawbar. This drawbar is tightened by means of a handwheel at the left-hand end of the headstock. The plate is located angularly by a key on the drawbar.

When the automatic cycle is initiated, the work is indexed by a Geneva motion, and at each index position, the cutter-head is fed into depth, and then rapidly withdrawn. The feed motion is imparted by a cam system, driven from a ½-h.p. electric motor. The cutter spindle, which is driven by a 2-h.p. motor, is run at 2,000 r.p.m. As may be observed, a safety guard is provided, which surrounds the cutter. Carried on an arm which is pivoted at the rear of the machine, this guard is automatically withdrawn, towards the rear, before the cutter-head advances at the beginning of the cycle. When the cutter-head is finally withdrawn, at the completion of the cycle, the guard is again advanced over the cutter, and the machine stops. Girl operators are employed, each of whom tends several machines.

RADIAL MACHINES

Another group comprises several Hoffmann special-purpose 2-spindle radial machines, of the type shown in Fig. 15, which are extensively employed on medium-size ball cages. These machines, also, are fully automatic, and each operator tends four spindles. At each station, the work is held between a spigoted register pad mounted on the indexing headstock spindle, and a similar pad on a screw-type tailstock. Two-piece cages are located angularly by the rivet holes, as at the set-up previously

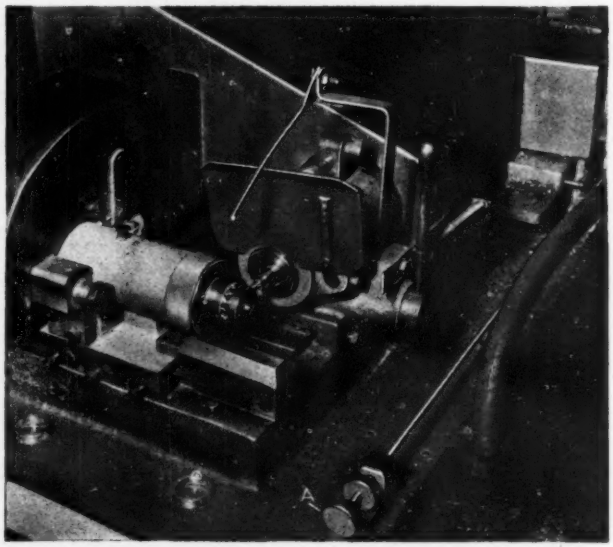


Fig. 16. This Pneumatically-operated Machine, Designed and Built by the Company, Machines 80 Pockets per min. in Cages for Magneto-type Bearings

described. At each index position, a horizontal cutter-head is advanced and withdrawn, and the machine stops automatically at the end of the cycle. In Fig. 15, the left-hand spindle is seen set-up for machining 15 profiled pockets, of $\frac{7}{16}$-in. major diameter, in a one-piece cage, and that at the right for producing 17 plain $\frac{3}{8}$-in. diameter holes in a two-piece cage. At both stations, the spade-type cutters are run at 3,100 r.p.m., and the cycle times for the components on the left- and right-hand spindles are 37·5 and 42·5 sec.

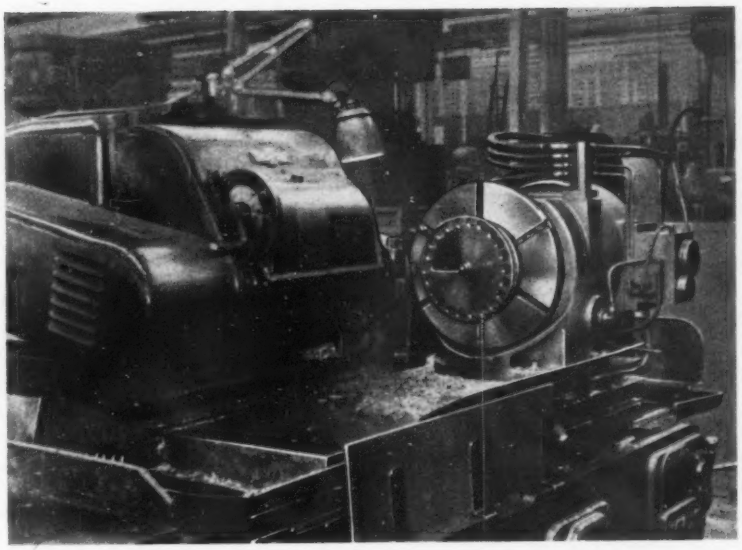


Fig. 17. Two Special Cincinnati Machines, of the Type Shown, are Employed for Producing Axial and Radial Pockets in Large Rings up to 25 in. Diameter

Another special-purpose radial machine, designed and built by the company, is shown in Fig. 16. Pneumatically operated, it is employed for machining the pockets in brass one-piece ball cages for magneto-type bearings. The work is clamped against a register spigot by means of a C-washer and a spring-loaded lever-operated drawbar, and the automatic cycle is initiated by depressing the push button A. Thereupon, the work is automatically indexed, in unison with a reciprocating motion of the horizontal cutter head. This motion is imparted by a cam mounted on a transverse shaft, situated behind the cutter head, and driven, through a V-belt, by an electric motor mounted beneath the table.

Another cam, mounted on the same shaft, actuates a pneumatic valve which controls the air supply to a cylinder for operating the indexing mechanism. An air pressure of 28 lb. per sq. in. is employed for the pneumatic system, and the cutter head makes 80 complete strokes per min. A separate electric motor drives the cutter spindle at 5,500 r.p.m., through a belt, and the machine stops automatically at the end of the cycle. At the set-up shown, 11 formed holes, of $\frac{1}{4}$ in. diameter, are machined in each cage ring in a floor-to-floor time of 14 sec. The radial thickness is $\frac{1}{8}$ in.

For producing ball and roller pockets up to 3 in. diameter in large cage rings, up to 25 in. diameter, the company have installed two special-purpose Cincinnati Hydromatic machines, one of which is shown in Fig. 17. Each of these machines has a stationary horizontal spindle-head, with the spindle arranged transversely. Drive to the spindle is taken from a 10-h.p. electric motor, through a variable-speed gearbox, which, in the example illustrated, provides a range of 9 speeds, from 306 to 3,000 r.p.m. The second machine has a modified spindle drive, designed by the company, which gives a speed range of 57 r.p.m. to 3,000 r.p.m., with a very large number of intermediate steps.

The hydraulically-operated, automatic-indexing workhead is mounted on a table which is arranged to reciprocate horizontally in a direction parallel with the axis of the cutter spindle. This table, also, is hydraulically operated, and the speed is variable steplessly from zero to 40 ft. per min. Provision is made for setting the workhead at right-angles to, or parallel with, the cutter spindle, so that the machine may be employed either for axial or radial work. The length of the table stroke is controlled by means of adjustable dogs at the front, which trip hydraulic reversing valves. A similar system on the rear of the table controls the indexing and locking arrangements for the workhead, in unison with the movements of the table.

For controlling the index positions, a large-diameter index plate is mounted on the rear end

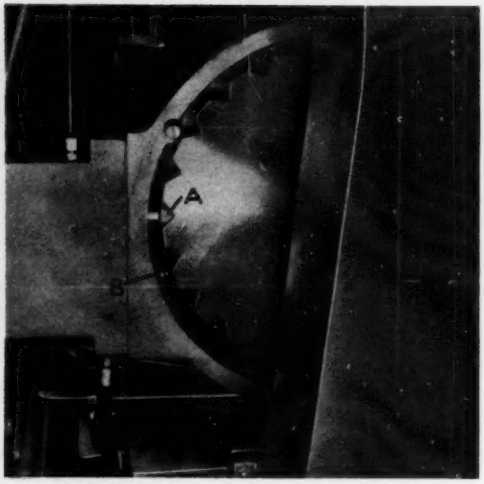
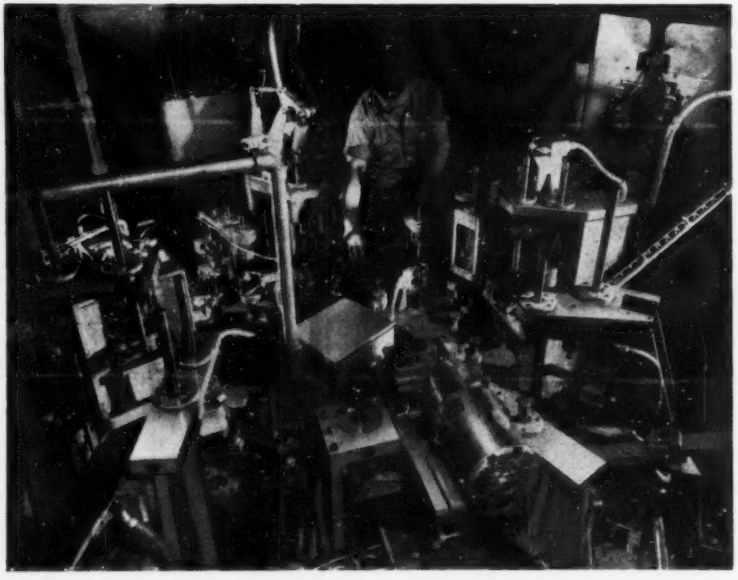


Fig. 18. Rear View of the Workhead of the Machine in Fig. 17, with Cover Removed

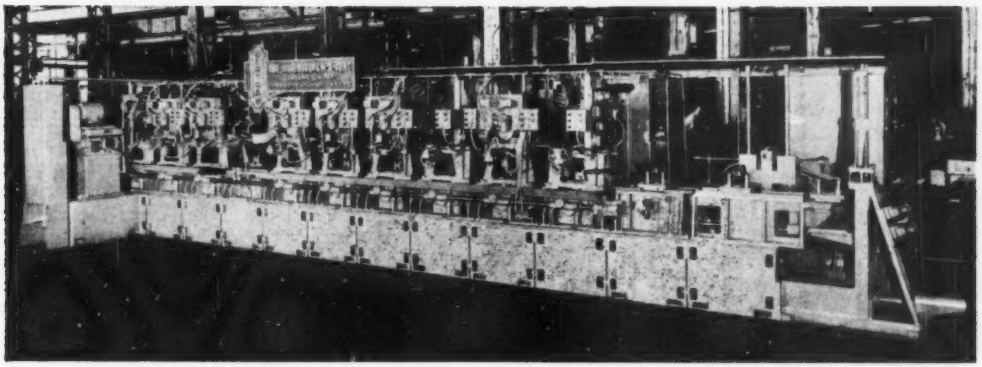
of the work spindle, as shown in Fig. 18. In this figure, it may be noted, the rear cover which normally encloses the mechanism has been removed. Various interchangeable index plates are employed, according to the number of positions required, and the hydraulically-operated index locking plunger may be seen at *A* in Fig. 18. A cam, mounted behind the index plate, operates a plunger *B* to stop the machine, with the workhead withdrawn from the cutter, at the completion of the fully automatic cycle. The arrangements for clamping and locating the work are similar to those on the other machines described, except that the clamping-plate is secured normally by tightening a central screw. In operation, the workhead is rapidly advanced towards the revolving cutter, and then slowed to the cutting feed rate. When the pocket has been machined, the head is rapidly withdrawn, and the work is indexed.

Fig. 17 shows a set-up for machining 22 axial pockets, of 1·0795/1·0765 in. diameter by 1·0745/1·0715 in. deep. in a 10¾-in diameter roller cage, to spacing limits of ±0·006 in. The spade-type cutter is run at 1,273 r.p.m., and the feed is 9 in. per min. Each cage is completed in a floor-to-floor time of 8 min. At another typical set-up, for machining 12 formed radial pockets, of 1·0725/1·0715 in. diameter, in 7½-in. diameter, 2-piece, floating type ball cages, the same speed and feed are employed. In this instance, the chordal spacing of the pockets is held within ±0·002 in., and each pair of components is completed in a floor-to-floor time of 51 sec.

Some further examples of the company's methods of cage manufacture will be discussed in a later article.



Sub-assemblies for front-suspensions are completed at the rate of 1,200 per hour with the equipment here illustrated which is installed in the new chassis parts plant of the Ford Motor Co., in Sterling Township, Mich., U.S.A. The operator loads the basic part on a multiple-fixture, circular table whereby it is indexed to a series of automatic work stations and returned as a completed sub-assembly for unloading. Faulty parts are rejected automatically



Canadian System of Unit-construction for Transfer Machines

By LEO WALTER

A system of unit construction to facilitate the building of transfer machines, and to reduce building costs, has been developed by John Bertram & Sons Co., Ltd., Dundas, Ontario, Canada. The system is based on the use of what are termed "block units," and a large 15-station machine for operations on differential housings, which has recently been built with these units, is shown in the heading illustration. Each block unit forms, in effect, an individual machine tool, complete with its own control system and push-button panel, and these units can be arranged in any sequence, replaced and interchanged, to suit production requirements. Provisions are made for the location of tooling and for connecting the individual transfer mechanisms, so that the units may be built-up to form transfer machines of virtually any size, and when they are thus arranged, all the units are controlled from a master panel at one end of the machine.

The master panel and its associated control gear serve to synchronize the operations at the various stations, and to regulate the transfer movements. Each block unit is connected to the main electrical circuit of the machine by means of cables and multi-pin plugs, and, once such connections have been made, control is effected automatically from the master panel. The electrical system has been developed by the Canadian Westinghouse Co., Ltd., and incorporates that company's Cypak units. These units have no moving parts, and it is claimed that they can operate faster, and for longer periods without maintenance or replacement, than can conventional relays.

With the Bertram system of block unit construction, working stations are arranged 30 in. apart, the bed elements being made slightly shorter, with provision for shim adjustment. Datum pins are incorporated, whereby adjacent stations can be set precisely to the 30-in. dimension, with the aid of a gauge, and since fixtures with individual location arrangements are employed at each station, it is stated that accumulative errors do not arise. Each base element has joint surfaces at each end, with dowel holes for alignment purposes, and the dowel holes on mating elements match, regardless of whether one element is turned through 180 deg. relative to the adjoining units. Base elements alone are used for idle stations and non-cutting operations. For machining stations, the base elements are employed with horizontal or vertical machining elements, which can be used singly or in various combinations—for example, double horizontal, with the machining elements mounted on wings at either side of the base, or horizontal and vertical, with the latter unit mounted on a column—and station arrangements of eight basic types are thus provided.

Workpieces to be machined are carried through the assembled block units on platens, which are loaded at one end and unloaded at the other. Single base elements are used to provide stations

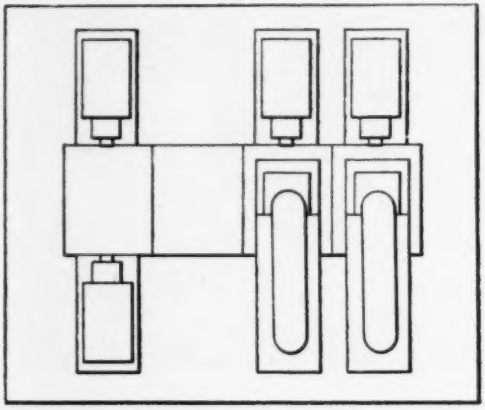


Fig. 1. In Order to Provide Access to at Least One Side of Each Block Unit, Idle Stations are Incorporated, as Here Shown Diagrammatically

for loading and unloading, and the empty platens are lowered by an elevator, returned to the starting end of the machine by roller conveyor, and raised by another elevator to the level of the transfer ways. Since it is necessary to provide access to at least one side of each machining element, the use of three such elements in a row is avoided, and a single machining element may be located on the opposite side of the transfer ways to those at the adjoining two stations, or a non-machining element (such as an indexing element) may be employed as a separator, as indicated diagrammatically in Fig. 1.

The construction of individual stations from standardized members is shown in Fig. 2. A base member *A* is either used alone, or is fitted with one or two wings *W*. Two sub-base members *B* are mounted on the main base, and support the transfer mechanism, platen-carrying and clamping arrangements, and the tool guiding members. The platen *C*, whereon the workpiece is located, rests on pads fitted to bars on the sub-bases, and is positioned accurately by two dowel pins. A fixture assembly *F* is secured to the sub-bases, and incorporates pneumatic (or hydraulic) clamping cylinders (or cylinder) *G*, also guide bushes, as indicated at *H*. Standard machining heads are mounted on either side or overhead, depending upon operational requirements, horizontal units, as at *J*, being located at the desired height by using suitable raising blocks *K*. Vertical machining heads *L* are attached to a column *M*, of the appropriate height. Where necessary, specially-designed machining heads are employed in place of the standard Bertram units.

The platen transfer and return arrangements are shown in the perspective drawing, Fig. 3. As already mentioned, the platens *A* normally rest on pads fitted to bars *B* at each station. Between the sub-bases at each station, there are two channel section bars, which are supported by rollers mounted on the ends of arms secured to cross-shafts, as indicated at *C*. Each cross-shaft carries a pair of arms, and the rollers enter the channel forms of the bars. The end of each cross-shaft is connected by a lever to a rod *D*, along the side of the machine, and this rod is built up from short lengths, which are coupled together by screwed connectors (resembling turn-buckles), as may be seen in Fig. 4, which is a close-up view of one station of the differential-housing machine. The arrangement is such that a length of rod at any station can readily be disconnected, to allow the complete block unit to be removed. One end of the rod assembly is coupled to a hydraulic cylinder, and when the ram of this cylinder is at the limit of its travel in one direction, the channel section bars lie below the level of the bars *B*, Fig. 3. The channel-section bars are connected by welded cross-members to form a rigid structure, and when the ram of the hydraulic cylinder

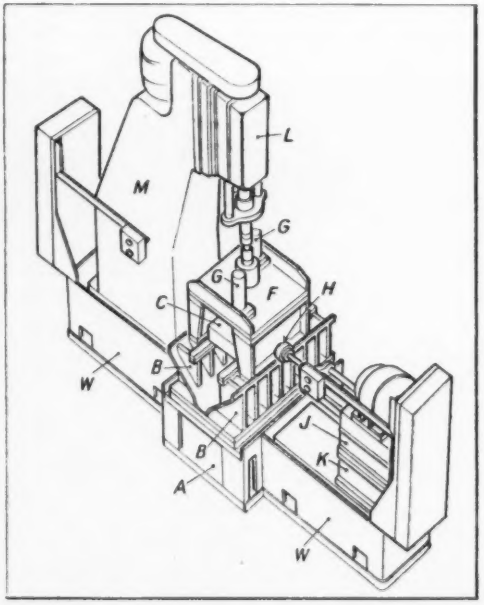


Fig. 2. The Arrangement of a Typical Block Unit is Indicated by this Perspective Drawing

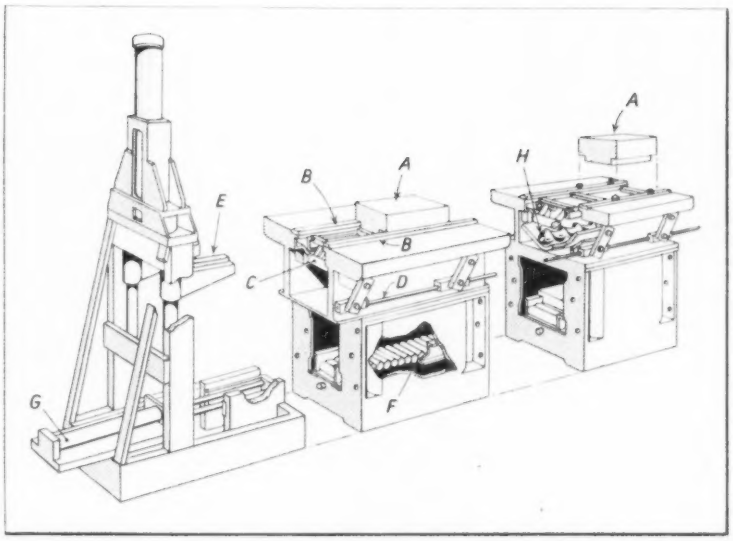


Fig. 3. In this Perspective Sketch, the Arrangements for Platen Transfer and Return are Illustrated

is moved in the other direction, this structure is raised, lifting the platens from their seatings, clear of the bars *B*. A second hydraulic cylinder is coupled to the end of the structure formed by the channel-section bars, and when this structure has been raised, it is moved forwards for a distance of 30 in., on its supporting rollers. In this way, the platens are moved from one station to the next, and the carrying structure is then lowered, to deposit the platens on their new sets of locations. When the structure is clear of the platens, it is returned to its original position, in readiness for the next transfer cycle.

On reaching the end of the machine, each platen is deposited on the platform *E* of a hydraulically-operated elevator. This platform is lowered during the next machining cycle, to align the platen with an inclined roller conveyor *F* in the lower part of the built-up base of the machine. The platen is thrust from the elevator platform on to the roller conveyor by the action of a hydraulic cylinder *G*, and moves, under the influence of gravity, to the entry end of the machine. Here, it is thrust by the following platens on to the platform of a second elevator, which lifts it to the level of the transfer ways. The platen is removed from the elevator platform by the carrier bars during the next transfer cycle.

Between the sub-base members of each station is located a screw-type chip conveyor *H*, which rotates in a steel trough. The chips produced by the machining operations are carried along the length of the machine by the conveyor and are discharged through a chute on one side, at the station which provides for cleaning chips from the platens and workpieces.

A further application of the Bertram system is illustrated by the 17-station transfer machine for operations on transmission casings, which is shown

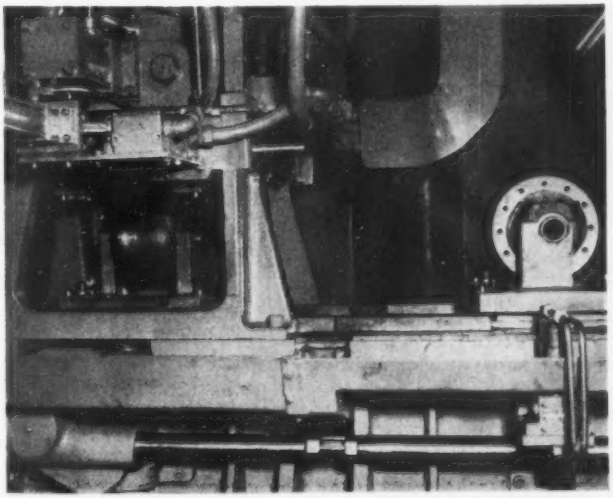


Fig. 4. This Close-up View of a Transfer Machine for Differential Housings Shows How the Operating Rods for the Work-lifting Mechanisms are Coupled Together

diagrammatically in Fig. 5. Each platen, in turn, is raised to the level of the transfer ways by an elevator at station 1, and a partially-machined casing is loaded at station 2. Earlier operations on the casings are carried out on a Bullard multi-spindle automatic, with the main spigot A of the workpiece projecting downwards. On the Bullard machine, all operations on the trunnion end of the workpiece are completed, and the seating face of the flange is machined. The operator of the Bullard machine also tends an adjacent machine for assembling trunnion bearing caps, and loads the Bertram transfer machine.

Two similar machining units are provided at stations 3 and 4 of the Bertram machine, and, respectively, provide for rough-machining the bore of the stem and drilling a side hole, and for semi-finishing the stem bore and tapping the side hole. Each machining unit consists of a bed element and two wings, with a vertical spindle head mounted on a column unit on one wing, and a horizontal head on a raising block on the other. The machining unit at station 3 is shown out of position to indicate how it can be withdrawn from the main machine line. The hydraulically-operated clamps at stations 3 and 4 are of a special design, to clear the cutting tools. In each clamp, a thrust pad, which contacts the work, is carried on the end of an arm, which is swung sideways, as it is raised and lowered, by the action of a helical track.

Station 5 is idle, and at station 6 there are two horizontally-disposed heads for boring the trunnions, which are tapped at station 7. The

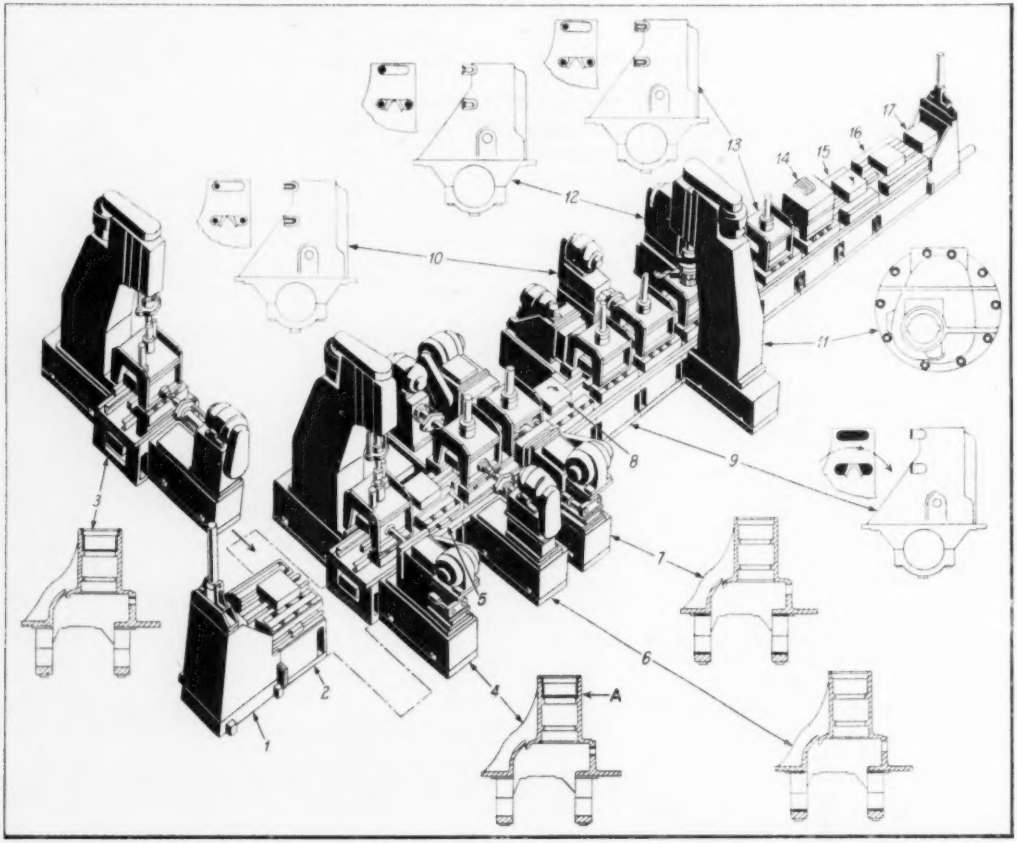


Fig. 5. The Arrangement of a Typical Transfer Machine Built from Bertram Block Units is Shown by this Perspective View. The Operation Performed at Each Station is Indicated Diagrammatically

platen and workpiece are indexed through 90 deg. at station 8, and at station 9 there is a single horizontal head, on a wing at one side of the transfer ways. This head is of a special type, and the cutter has a planetary motion to clear a web on the workpiece. With this head, three pads are milled at one setting, and a pad on one side of the web is milled first, as the cutter spindle follows a C-shaped path, as indicated by chain-dotted line. A pad at the upper end of the casting is milled next, and then a pad below it, on the opposite side of the web to the first. At the start of the milling cycle, the cutter spindle is advanced through an opening in the side of the fixture, before the planetary motion is engaged.

A hole is drilled in each of the milled pads at the next station (No. 10), and probes are advanced into these holes at the following station (No. 11) to check that none of the drills at the preceding station has been broken, and that the holes are of the correct depth for tapping. At station 11, there is also a vertical head fitted with a 10-spindle adapter, which carries tools for spotfacing the holes in the flange, that were drilled on the Bullard machine. The drilled holes in the pads are countersunk by tools in a multi-spindle adapter on a horizontal head at station 12, before they are tapped at station 13.

Swarf is removed from the platen and work by washing with coolant and blowing-off with compressed air at station 14, and the platen and work are indexed through 90 deg., to return the platen to its initial alignment, at station 15. The workpiece is removed from the platen at station 16, unloading being carried out by the operator of a special-purpose precision boring machine, which provides for finishing the three main bores of the workpiece at one setting. The empty platen is advanced on to an elevator at station 17, and is lowered to the level of the return roller conveyor, below the transfer ways. It is thrust on to the conveyor by a hydraulic ram, and is gravity-fed to the elevator at the entry end of the machine. The machine operates on a 70-sec. cycle, and coolant is applied to the cutting tools by a mist system.

The author acknowledges the assistance he has received from John Bertram & Sons Co., Ltd., and wishes to express his thanks to this company and to *Canadian Machinery and Manufacturing News* for permission to reproduce the photographs and drawings employed to illustrate the text.

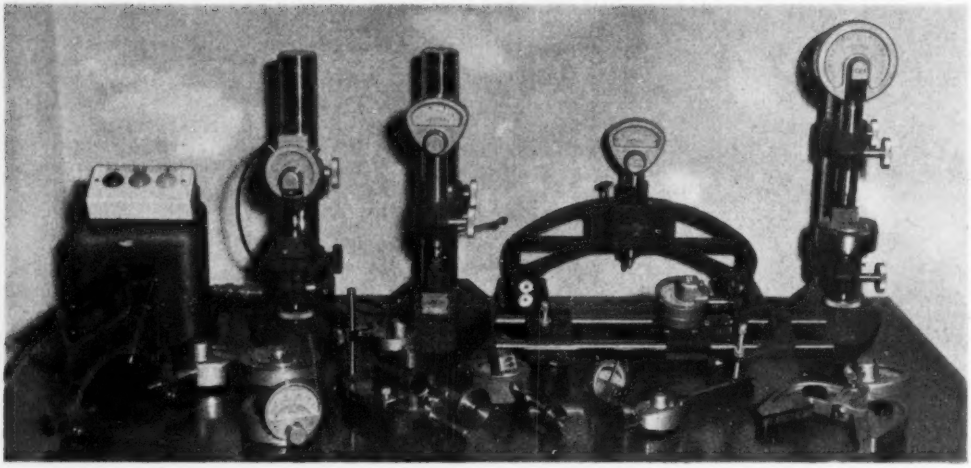
Diesel Engine Pistons Reclaimed by Welding On New Ring Carriers

Considerable economies are being obtained in the U.S.A. by reclaiming aluminium pistons for locomotive diesel engines. In the accompanying illustration, a worn piston, as removed from the engine is seen at the lower left. The piston is machined to receive a new ring-carrier portion of cast aluminium (upper left). Next, the ring carrier is welded in position, a piston after this stage being seen in the centre. Finally, the piston is finish machined and polished (right).

It is stated that the cost of reclaiming a piston in this manner is 30 dollars, as compared with 100 dollars for a new piston, and a piston can be restored as many as five times.

Pistons of the smaller sizes are welded automatically by the Sigma process on a Linde SWM-3 machine. Two passes are required and the welding time per piston is 2 min. Manual welding is employed for the larger pistons, and the operation is completed in one pass with a type HW-11 torch which is supplied with power from a Linde SWM-2 portable Sigma welding unit.

Diesel Engine Pistons are Reclaimed by Welding on a New Ring Carrier



The CEJ Mikrokator

Design, Application, and Some Aspects of Production

Among several leading engineering firms situated in the district of Eskilstuna, which is one of Sweden's oldest and most important industrial centres, is Aktiebolaget C. E. Johansson. The origins of this company date from the time when Carl Edvard Johansson, its founder, made the first gauge-blocks, for the Royal Swedish Small-arms Factory, in 1892, and subsequently began small-scale gauge-block production in 1895. When it was founded, in 1911, the company was devoted exclusively to the production of gauge-blocks and accessories. Since that time, however, the range of products has been considerably extended, but gauge-block making still constitutes the major part of the company's activity.

At the main factory in Eskilstuna, some 450 people are directly engaged in producing gauge-blocks and accessories, and such items as angle-blocks, plain and threaded ring and plug gauges, adjustable limit snap-gauges, thread-measuring equipment, micrometers, Mikrokator instruments of various types, and interference microscopes. Among the screwcutting and other tooling equipment also manufactured may be mentioned taps, dies and holders, Jacobs-type chucks, Coventry-type die-heads, and circular form-tools.

Gauge-block work is also carried on at a subsidiary factory at Vingaker, and a separate company, A.B. Deltameter, has been set up in Stockholm, for the production of the range of Deltameter measuring instruments and associated equipment. The Deltameter system, which is incorporated in a number of modern machine-tools, was originally developed by Sandvikens Jernverks Aktiebolag, for the continuous dimensional control and automation of some of their own production processes. Subsequently, Aktiebolaget C. E. Johansson acquired the world manufacturing and selling rights for the Deltameter instrument, for all applications.

Originally established in Coventry, the associated British company, C. E. Johansson, Ltd., moved to their present address at Southfields Road, Dunstable, Beds., in 1948, where, as was mentioned in MACHINERY, 91/166—19/7/57, several additions to plant and premises have recently been made. The current range of products includes high-speed steel ground-thread taps, circular thread-form chasers, ring and plug screw-gauges, thread-rolling dies, plain plug-gauges, thread-milling hobs, and Coventry-type die-head chasers. In addition, the British company acts as agent for the products of the Swedish firm.

THE MIKROKATOR

The CEJ Mikrokator is a shock-resistant, dial-type measuring instrument, capable of high amplification, which incorporates a thin twisted metal strip. On either side of the central portion, to

which the pointer is attached, the strip is twisted in opposite directions, by permanent set. When the strip is stretched, the centre portion, and consequently the pointer, turns about the longitudinal axis, and the angular extent of this movement is proportional to the elongation of the strip. This principle, which was the invention of Mr. Hugo Abramson, of Aktiebolaget C. E. Johansson, is applied, in practice, in the manner illustrated in Fig. 1. This figure shows, at *X* and *Y*, two typical arrangements, as employed in the type 510 and 500 Mikrokators, respectively. The type 510 instrument has a large cylindrical shank, whereby it may be mounted on a comparator stand or other suitable support, whereas the type 500 instrument is of more compact design.

In the type 510 Mikrokator, the measuring stem *A* is suspended on two split spring diaphragms *B*, so that it can move vertically, without friction. At the upper end, the stem is also connected to one limb of the spring knee *C*, which is shown in greater detail in the enlarged view at *Z*. To the vertical limb of this knee, which serves, in effect, as a bell-crank, is attached one end of the twisted strip *D*. At the opposite end, the strip is attached to an adjustable leaf spring support *E*. The adjustment of this spring is such that its effective stiffness can be varied, and it permits of setting the working tension range of the twisted strip, so that, for a given deflection of the measuring stem, the required movement of the pointer is obtained.

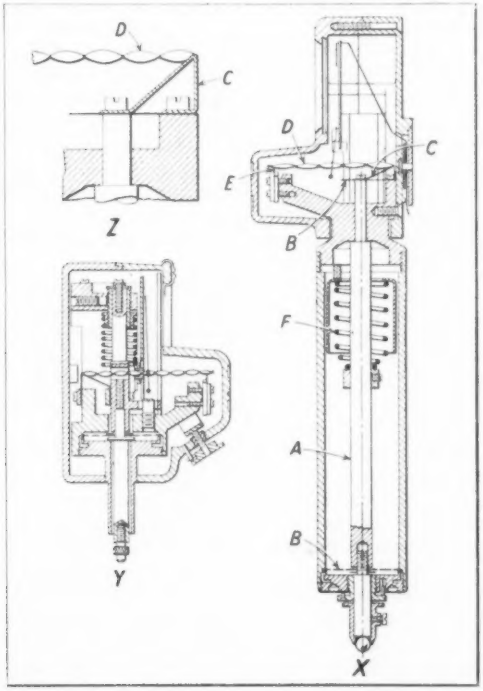


Fig. 1. Sectional Views of Typical CEJ Mikrokator Instruments, Showing the General Features of the Design

In order to keep the inertia of the moving masses to a minimum, so that the instrument is sensitive and shock-resistant, the strip and pointer are very small and light. The twisted strips are of phosphor bronze, 0·06 mm. and 0·12 mm. wide, and 0·0045 and 0·0025 mm. thick. Pointers are of glass tube, tapered, over two-thirds of the length, from 0·06 mm. diameter, to 0·03 diameter, and at the outer end of each, to render it visible, there is attached a small disc and rectangle of duralumin foil, only 0·001 mm. thick. Pointers of this type, as well as being extremely light, are strong, durable, and flexible. With this arrangement, the moving masses are so small that they can withstand violent accelerations and shocks without damage.

For a typical strip, 0·06 mm. wide by 0·0025 mm. thick, twisted through 4,000 deg., the force required to produce a 90-deg. rotation of the pointer is approximately 0·3 gramme. This force can be reduced by about 90 per cent by balancing the initial tension of the strip against that of a spring knee, of the type mentioned earlier. Such a knee may also be employed to provide an additional amplification. For example, a strip of the proportions mentioned, when used with a pointer 30 mm. long, will give an amplification of approximately 5,200:1. With a knee of suitable ratio, this amplification can be increased by ten times, and should even higher amplifications be required, they can be obtained by coupling the spring knee to a lever. By these means, a stable amplification of more than 200,000:1 is possible, and amplifications as high as 500,000:1 have been produced experimentally, although it was not ascertained whether stability could be achieved under these conditions.

It will be appreciated that a twisted strip of the type described has a greater overall length when measured along the spiral edges than on the axial centre-line. Thus, when tension is applied to the strip, untwisting is caused by the elastic elongation of the central portion. In the extreme condition, when the portion has been elongated to such an extent that its length is equal to that of the edges, practically all the twist disappears. For an instrument of very high sensitivity, therefore, a perforated strip is used, which elongates more readily on the centre-line.

Mikrokators in the standard range have scale

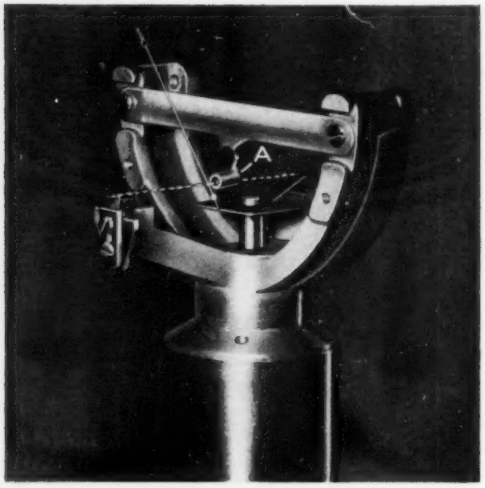


Fig. 2. Partly-assembled Type 510 Mikrokator, Showing the Die Cast Frame, Spring Knee, and Oil-damping Sleeve, *A*

graduations from 0·01 to 0·00001 mm., or 0·0001 in., to 0·0000005 in., and the guaranteed accuracy of the indications is within ±1 per cent. The measuring ranges are from 0·40 to 0·001 mm. or 0·020 to 0·00004 in., and the operating pressure on the measuring stem is normally 250 grammes (or 0·5 lb.). This pressure, it may be noted, is provided by the spring *F*, Fig. 1.

If required, instruments can be supplied with an adjustable or fixed measuring pressure up to 1,200 grammes (2 lb.), or in which the total variation in pressure required for the full deflection of the pointer does not exceed 0·3 grammes (5 grains). All instruments with measuring pressures of less than 10 grammes are arranged for pressure adjustment, and, for certain work, instruments with a measuring pressure of only 0·3 grammes, for the full deflection of the pointer, can be supplied.

The various elements of the amplifying mechanism described are mounted on a die cast frame of the type shown in Fig. 2, which, for the particular instrument illustrated, is screwed into the top of the hollow steel shank. An arm projecting from the front of the frame carries the adjustable leaf-spring support, and there is a corresponding flat mounting face for the upper diaphragm and the spring knee at the opposite end of the twisted strip. As may also be observed in Fig. 2, the frame is in the form of a semi-circular yoke. The limbs of the yoke serve to support the scale, which is secured to them by screws. Also secured to the limbs, at their upper ends, is a cross-member, which carries a short, split sleeve A. This sleeve has a bore of a diameter that affords clearance for the twisted strip, which passes through it, and encircles the strip immediately behind the pointer.

Because of the light weight of the glass pointer, in relation to its rigidity, it has a high natural vibration frequency, and the damping effect of air is therefore correspondingly high. Further damping is provided by a drop of oil, which is placed in the sleeve surrounding the twisted strip, where it is retained by capillary action. As a result, although the instrument is very sensitive, and has an almost instantaneous response, oscillation of the pointer is negligible. The die cast frame also serves as a means of locating and attaching the protective cover and glass, and in some instances, this cover is equipped with adjustable pointers, which can be set to indicate the tolerance range.

APPLICATIONS

The Mikrokator principle described, and the various instruments in which it is incorporated, form the basis of a comprehensive range of measuring equipment and accessories. Some representative examples from the range are shown in the heading-illustration, and include Mikrokators on comparator stands; Ridermikrokators for checking cylindrical work; a Mikrokator Micro-snap gauge; a typical load dynamometer; a surface-finish indicator; a bore Mikrokator; an Intexometer for measuring large internal and external diameters; a Minikator; and a typical El-Mikrokator and stand, with relay and light-signal box.

Mikrokators of the recently-introduced El-series, are equipped with adjustable electrical contacts, which can be set to operate at any desired scale readings, for defining the tolerance range. These contacts, which have a sensitivity of discrimination of 0·5 microns (0·00002 in.) may be employed for the automatic operation of coloured signal lamps, machine controls, or sorting mechanisms. The contacts are designed to operate on current loadings not exceeding 0·000005 amp. and a maximum voltage of 10, and the instruments must, therefore, be used in conjunction with suitable relays. For this purpose, the type 1511 double relay unit is available, which operates on a 220 volt A.C. supply. This unit, which is coupled to the instrument through a three-core lead and plug, incorporates a transformer and rectifier. The latter supply current to two thyratrons, which control two electro-magnetic relays.

A 10-volt D.C. supply is fed to the contacts of the Mikrokator, by means of the three-core lead

already mentioned, and the contacts serve to control the grid current to the thyratrons. Each relay is provided with two micro-switches, and currents up to 10 amp., at a maximum voltage of 460, can be handled. A 6·3-volt A.C. output, is also provided, for operating three signal lamps of different colours, for visual indications. El-Mikrokators are available with scales reading to 0·0002 in., 0·00005 in. and 0·00002 in., with measuring ranges of 0·016 in., 0·004 in. and 0·002 in., also with metric graduations.

DIAMETER MEASUREMENT

Ridermikrokators are designed for checking circular work by the "three-point" principle. One of these instruments comprises a Mikrokator mounted in a vee body, which has an included angle of 60 deg. between the hardened and lapped contact faces. If required, anvils of cemented carbide can be provided. Suitable for checking out-of-roundness of cylindrical ground work, it is available in four sizes, covering a total diameter-range of ⅜ in. to 10 in. The instrument may also be used as a comparator, for checking the diameter of a component against that of a cylindrical master.

A large Ridermikrokator has a girder-type frame, and is available in three sizes covering a diameter-range of 10 in. to 60 in. The frame is provided with a contact-roller at each end, and a Mikrokator is mounted centrally between them. Comparative readings are taken with the instrument set up on the surface to be measured, and on a flat surface, with a suitable gauge-block combination beneath the measuring stem. The equipment can also be used for checking camber on such components as large rolls.

The Micro-snap gauge resembles a conventional snap-gauge of the C-frame type, except that one anvil is replaced by a Mikrokator, and an adjustable back-stop is provided, in the throat. These instruments, which are available in various sizes covering a total diameter range from zero to 10 in., are designed to facilitate checking work in position on machines, and each is provided with a heat-insulating handle.

For checking bores, with the work in position or removed from machines, the company has recently introduced an instrument, which comprises a Mikrokator mounted in a holder. The latter is fitted with a measuring head of cylindrical form, and provided with spherical contacts of ruby. A cover of flexible plastics material is provided on the body of the instrument, to insulate it from the warmth of the hand. The measuring heads are available in various sizes, covering a diameter-range from ⅛ in. (3 mm.) to 1 in. (25 mm.) and depths from 0·6 in. to 3 in.

The Intexometer is a trammel-type instrument with a capacity of 125 to 500 mm., or 125 to 1,000 mm. It incorporates a pair of stainless steel tubes which are held parallel with each other by means of four adjustable clamps. One of these clamps is fitted with a fixed measuring contact, and another with a movable contact. The latter clamp, which serves as a mounting for the Mikrokator instrument, is equipped with a lever which carries the movable contact. This lever also engages the stem of the Mikrokator. The other two clamps are fitted with screw-type depth stops, which serve to hold the equipment square, in relation to the dimension being measured. To convert the equipment from internal to external measurement, the clamps carrying the contacts and the Mikrokator can be transposed on the tubes.

LOAD MEASUREMENT

In the load dynamometers produced by the company, the Mikrokator principle is applied in the following manner. The body of the instrument is in the form of a spool of special steel, with permanent modulus of elasticity characteristics, and a high elastic limit. When the instrument is in use, the load to be checked is applied to the ends of the spool, and is indicated directly by a Mikrokator-type dial and pointer, on the front of the body. The latter has an axial bore, in the upper end of which is mounted a micrometer screw. At the lower end, this screw engages a lever mounted on a leaf-spring hinge, and the free end of this lever engages the horizontal arm of a spring knee, similar to that already described. This knee is associated with a twisted strip, pointer, and scale, the latter being graduated to read directly in terms of load units.

The micrometer screw serves for zero setting, and for this purpose it can be rotated through a worm drive, by means of a key-shaft projecting from the body. When load is applied to the instrument, it is compressed axially, and the lever mounted on the leaf spring, near the bottom of the bore, is thereby deflected by the lower end of the micrometer screw. This deflection is communicated to the spring knee, and thus actuates the Mikrokator system so that a corresponding reading is obtained on the scale. These instruments are available with different scales for measuring in metric, short or long tons, and in maximum capacities ranging from 2,000 lb. to 500 tons (long). Normally, the accuracy of the reading is within ±1·5 per cent, but specially made instruments can be supplied, to give an accuracy

within ±1 per cent, over the upper nine-tenths of the measuring scale that is employed.

EXTENSOMETERS

The Mikrokator principle is also utilized in two types of extensometer instruments, produced by the company, for direct measurement of elastic deformation of various engineering components, or test pieces. One of the instruments has an adjustable gauge length of 3 mm. to 11 mm. (⅛ to 7/16 in.) as compared with the nominal 50 mm. (2-in.) gauge length of the other.

Each instrument is provided with fixed and movable gauge-points, which are pressed against the component to be tested. The movable point is coupled to a typical Mikrokator amplifying system by means of a spring or spring knee, and changes in the gauge length are indicated directly by the pointer and scale. On the smaller instrument, the gauge length is adjustable over the range indicated, to facilitate checking localized stress-regions of small area, for example, in fillets or welds, or in the vicinity of holes.

With the other type of instrument, the gauge length (50 mm. nominal) can be increased to a maximum of 250 mm. (10 in.) by means of extensions. This instrument, which is intended chiefly for determining the properties of materials, and dimensional changes in major structural elements, is available with inch or metric scales.

SURFACE-FINISH MEASUREMENT

Another application of the Mikrokator principle is in the field of surface-finish measurement, for which the company produce two types of instrument. One instrument has a special stand, which supports a Mikrokator, fitted with a diamond or steel stylus, above the work. Provision is made for raising the stylus, traversing it through controlled lateral increments, and lowering it into contact with the work again, so that a series of readings is obtained. Lateral motion is obtained manually, through a ratchet and lever system associated with a micrometer screw. The increments of movement are adjustable, and the smallest is 0·005 mm. (or 0·0002 in.). Contact pressure of the stylus is adjustable from zero to 20 grammes, with a maximum variation of 0·3 grammes for the full deflection of the pointer. Scales with graduations ranging from 0·0005 mm. (0·00002 in.) to 0·0001 mm. (0·000002 in.) can be provided.

A smaller and simpler general purpose instrument comprises a Mikrokator-type body with three spherical contacts, of cemented carbide, on the underside. Projecting through a hole in one of the contacts, there is a diamond stylus with a tip radius of approximately 0·01 mm. (0·0004 in.). In use, the instrument is placed with the three contacts resting on the surface to be investigated, and is slowly traversed along it. Traversing may be performed manually, or with the aid of a feed device, several of which are available with the instrument. With the majority of these accessories, feed is effected by means of a micrometer screw, and in some instances provision is made for locating the work, or guiding the instrument in relation to it.

A typical accessory comprises a pillar and base, designed to hold the instrument in such a manner that only the contact with the stylus is in engagement with the work. The instrument holder is mounted on a horizontal leaf-spring "hinge," and is provided with an adjusting screw which enables the instrument to be raised or lowered, so that either the stylus alone is in engagement with the surface to be checked, or both stylus and contact. In this way, the instrument may be used for checking either the secondary texture (waviness) or the primary texture (roughness).

It may also be noted that a Mikrokator is incorporated in a micro-hardness tester made by the company. This instrument, with a range of accessories, may be employed for micro-hardness testing by the Vickers diamond pyramid method, by measuring the diagonal, or the recovered depth of the impression. It can also be used for the Knoop diamond system, and for scratch testing with a Vickers diamond, or a diamond specially designed for the purpose. The accuracy of location of the indentations is such that a number can be made in each individual crystal, and the equipment can also be used for hardness-testing very small components. For example, as many as 9 indentations can be made on the end of a watch-shaft pin of only 0·1 mm. (0·004 in.) diameter.

MIKROKATOR PRODUCTION

Owing to the basic simplicity of the design, the methods employed for producing the frames, shanks, cases, and similar details for the Mikrokator instruments, are generally straightforward. The frames, as already indicated, are die cast, and require little machining, other than drilling, tapping, and facing. On the larger instruments, the lower portion of the frame, which is screwed directly into the tubular shank, is turned and threaded. The cases of the instruments are either die cast, in mating halves, or are moulded in plastics material, which has the advantage of being a good heat insulator.

Of considerable interest, however, are the methods which have been developed for making the twisted strips and pointers, for the amplifying mechanisms. These items are produced in a special department, where the instruments are also assembled by skilled girl operators. The assembly section, it may be noted, completes approximately 100 instruments a week. As already indicated, satisfactory performance of the instruments largely depends on the characteristics of the very fine glass tubes which are used for the pointers. The latter are made from glass tube of 0·06 mm. (0·002-in.) external diameter, and 0·03 mm. (0·001-in.) bore, which is drawn down to give the necessary taper.

MAKING THE POINTERS

For producing the fine parallel tube from which the pointers are made, the company have constructed the rig shown in Fig. 3. It is built almost entirely of wood, and this form of construction has proved quite satisfactory, in view of the fact that it is only required to operate occasionally. An output of approximately 2,400 metres of tube per hour is obtained, which is sufficient to meet the requirements for several weeks' instrument production.

The stock from which the parallel tube is drawn, is glass tube of 2·5 mm. external diameter, with a bore of 1·8 mm. This material is supplied in 60-cm. lengths, each of which is sufficient for approximately 800 metres of the fine tube. A length of stock is held vertically, by the upper end, in a clamp *A*, Fig. 3, which is slowly fed downwards by a screw, the latter being driven by an f.h.p. electric motor through a variable-speed reduction unit. At the lower end, the stock passes through an electric resistance heating coil, which is supported on a metal plate projecting horizontally from the main column. This coil is surrounded by a quartz tube, which conserves heat and enables the heated portion of the work, and the coil, to be observed. The quartz tube is seen at *B* in Fig. 4, in which the main elements of the rig are shown.

Reduction of the stock takes place mainly at a point just below the heater coil, whence it passes through a hole in the heater support-plate, and between the rubber-faced metal rollers *C*. The right-hand roller is driven by another f.h.p. electric motor, through a variable-speed reduction unit, and a system of belts and pulleys. Drive is transmitted by friction from the right-hand to the left-hand roller, the latter being spring loaded. Mounted immediately beneath the rollers, there are two curved-strip plates, which are arranged as close to them as possible, without actually touching. The reduced tube passes through a narrow gap between the adjacent edges of the plates, and is coiled on the conical turntable *D*, Fig. 3, which is also driven by an f.h.p. motor.

Connected to earth, these plates serve to discharge any static which may tend to accumulate on the rubber of the rollers, or on the glass. This precaution is necessary to ensure that the very fine tube does not cling to the rollers or to other parts of the rig, and descends cleanly from the rollers on to the turntable, whence it is lifted off in the form of a loosely-wound skein.

As may be observed in Fig. 4, a microscope is mounted immediately above the rollers. This instrument, which has a magnification of 120×, is equipped with an eyepiece graticule-micrometer, and is so arranged that the enlarged image of the filament is in view while drawing is in progress.

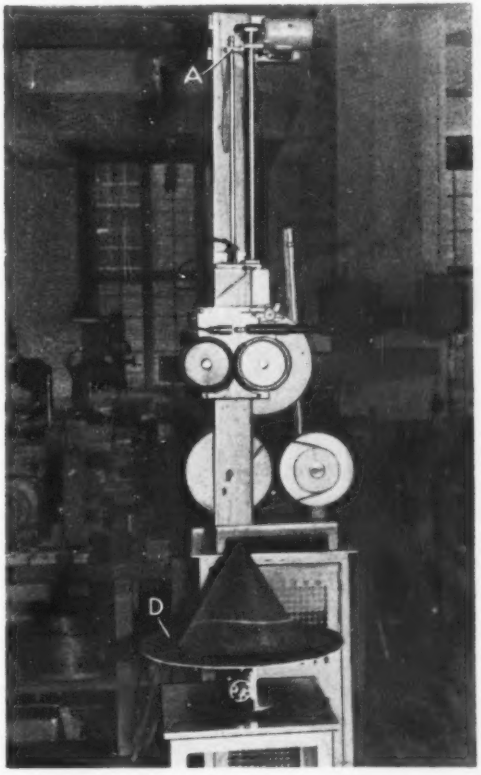


Fig. 3. This Special Rig, Built by the Company, is Employed for Drawing the 0.06-mm. Diameter Glass Tube for the Pointers, at the Rate of 2,400 metres per hour

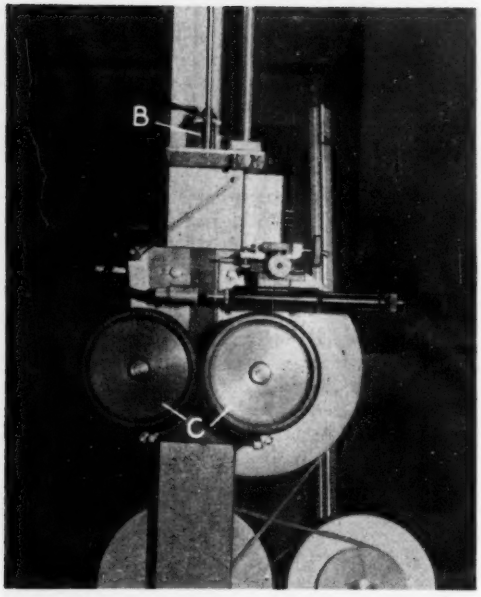


Fig. 4. Close-up View, Showing the Heater, Microscope, Rubber-faced Rollers, and Copper Earthing Plates

In this way, a constant check may be maintained, on the internal diameter, external diameter, and wall thickness of the tube. The necessary control, for maintaining these dimensions, is effected by adjustments to the temperature of the heater coil, the speed of drawing, and the rate of down-feed of the glass-tube stock.

INTERNAL PRESSURE CONTROL

Another important factor—the internal air pressure in the tube—is also controlled. For this purpose, there is a sealed reservoir *E*, Fig. 5, mounted on the base of the rig, which contains a quantity of water, with an air-space above it. Coupled to the lower portion of the reservoir, through a tube extending almost to the bottom, there is a water-column tube *F*. Another tube *G*, in the top of the reservoir, communicating with the air-space above the water, is connected to the upper end of the glass-tube stock. In the tube *G*, there is a tee connection, through the branch of which pressure is applied to the air-space above the water, and to the interior of the work tube. The air pressure on the surface forces water into the tube *F*, in which it is thereby raised to a height depending upon the pressure. When the branch connection is then sealed off, the weight of the water column maintains the pressure.

In practice, the pressure is adjusted, with the rig in operation, so that the drawn tube is of the required proportions, as ascertained by means of the microscope. The branch connection is then sealed-off, as described, and the water column thereafter maintains the pressure automatically. At the time when the branch-connection is sealed off, the level of the water column is noted, by reference to a scale. Any loss of pressure, while the rig is in operation, is indicated by a fall in the level of the water column, and is readily restored by introducing more air into the system, so that the level is maintained. The volumetric loss of air from the system is, in fact, negligible, so that the rig may be run for fairly long periods without pressure adjustment.

TAPERING

As has been indicated, the finished pointers are tapered, over two-thirds of their length, from the 0·06 mm. external diameter of the reduced tube, to 0·03 mm. at the tip. Tapering in this manner is performed by girl operators, with simple equipment of the type shown in Fig. 6. The skein of hollow glass filament is lifted off the turntable of the rig, cut through, and straightened-out, so that all the "strands" lie roughly parallel. This bunch

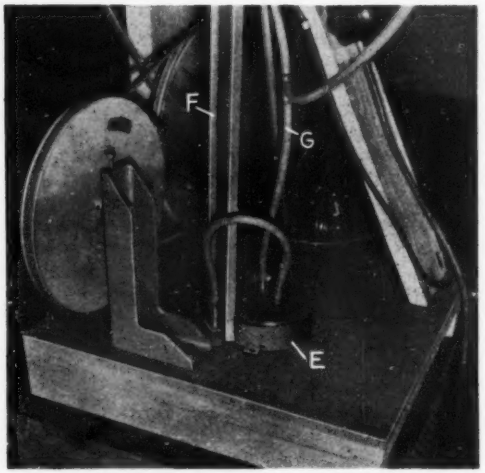


Fig. 5. A View of the Rig from the Rear, Showing the Reservoir and Water Column Tube for Maintaining Internal Air Pressure in the Stock Tube

Fig. 6. The Reduced Tube is Tapered with the Aid of a Small Strip-type Resistance Heater, as Here Shown. Considerable Skill is Required

is then laid on the bench, in front of the operator, who withdraws one length at a time.

Tapering is performed by heating the tube locally, by holding it in contact with a small strip-type electric resistance heating element, mounted at a convenient height on the bench. As soon as the tube is sufficiently heated, the ends are pulled rapidly in opposite directions, and, at the same time, it is lifted clear of the heating element. In this way, the heated portion is reduced to the required smaller diameter. When reduced, the tube provides two pointers, one on either side of the point of minimum diameter. The tube is cut by placing it on a hard surface, and pressing the edge of a knife against it, and at this stage, extra length is allowed for the subsequent trimming whereby the required relationship of the tapered and plain portions is obtained. The work of tapering calls for a high degree of skill, and the operators undergo a lengthy period of training.

Considerable skill is also required in handling the 0·001-mm. (0·00004-in.) duralumin foil, from which the "visible" portions of the pointers are produced. As has been mentioned, these portions comprise a disc and a rectangle of the foil, and are secured to the glass tube by means of a special thermo-setting adhesive. The disc is of 1·5 mm. diameter, and the rectangle is 0·2 mm. wide. These items are cut from the foil, which is supplied in strip form, 2 mm. wide. The material is so thin and light that it floats freely in air, and even a slight draught is sufficient to blow it away. Normally, the working areas of the operators engaged on this work are screened from draughts, by curved transparent plastics guards. In Fig. 7, however, which shows a typical station, the guard has been removed for photographic purposes.

The operator is seen punching the 1·5-mm. diameter discs from a short length of the foil strip. For this purpose, the strip is placed on a flat plate of zinc, with the aid of tweezers, and is held down by a small weight on each end. A hollow punch is employed, and an internal plunger enables each "blank" to be ejected, as soon as it has been cut. The blanks are usually ejected on to the surface of a flat plate, so that assembly to the pointers is facilitated. A small amount of the adhesive is applied to each pointer and it is then lightly placed on one of the discs, so that the latter is picked up. Narrow rectangles of the foil, cut from the strip with the aid of a knife, are attached to the pointers in a similar manner.

TRIMMING THE FOIL

After each pointer has had its foil attached, it is placed vertically in one of a series of holes in a metal block. When all the holes in the block have been filled, it is loaded into an electrically-heated

Fig. 7. Cutting the Pointer Discs from 0.001-mm. Duralumin Foil, with a Hollow Punch on a Zinc Plate

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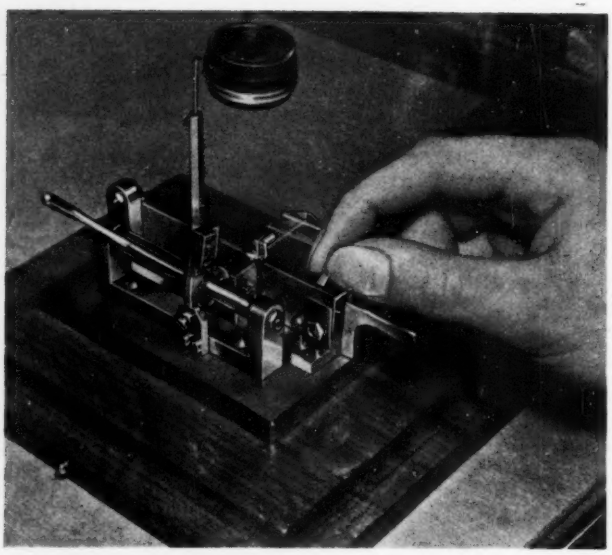


Fig. 8. This Special Fixture is Employed for Trimming the Parallel Portions of the Foil to a Width of 0.2 mm., after Assembly to the Pointers

warm air oven, in which the adhesive is cured. The rectangular portions of foil, as first applied, are considerably oversize, and after the adhesive has been cured, they are trimmed to the final 0·2 mm. width with the aid of the special fixture shown in Fig. 8. In the centre of the fixture there is vertical block, the upper face of which has two parallel cutting edges, on either side of of a 0·2-mm. wide slot. Mounted exactly in line with this slot, there is a miniature vice, the jaws of which are actuated, through a linkage system, by the small finger-lever seen in use in the illustration.

Each vice jaw is equipped wtih a gold pad, and these pads are so designed that they are slightly resilient. A positive stop is also provided, so that the jaws cannot be closed too far.

In loading the fixture, the pointer is placed between the vice jaws, with the surplus material on the edges of the foil resting on the top of the slotted block. The opposite end is located in a narrow slot formed by the adjacent straight edges of a pair of vertical plates, and rests on a horizontal datum face. In this position, the disc is clear of the vice jaws, in a narrow space between the latter, and the adjacent face of the slotted block. When the vice jaws are closed, the tube is automatically aligned with the centre of the slot, and this condition is verified by observing the work through a magnifier.

If any misalignment is observed, it is invariably due to slight sideways springing of the tube, which can usually be corrected by opening the jaws and closing them again, once or twice, or by easing it into position with the point of a pair of tweezers. Once the pointer is correctly aligned, a cutting blade, 0·2 mm. wide, mounted on a horizontal shaft arranged at right-angles to the axis of the work, is operated. This blade projects radially from the shaft, which is turned by means of a small hand-lever. The blade carries the central portion of the foil a short distance downwards into the slot, so that it is sheared by the cutting edges on either side. During this stage, the glass tube bends as it is depressed by the cutter, but it is sufficiently elastic to recover completely. After the foil has been trimmed, it is coated with a thin, quick-drying matt black paint, and the pointers are then passed to the assembly section, where they are secured to the twisted strips.

The rolling, trimming, and twisting of the strips, and some of the methods employed in assembling the amplifying mechanisms, will be disscussed in a later article.

LEXAN THERMOPLASTIC MATERIAL. In a recent issue of the *General Electric Review*, it was announced that a new thermoplastic material, known as Lexan, has been developed by the Chemical Development Department, Pitsfield, Mass., of General Electric, U.S.A. This material has high electrical resistance properties; can be formed by the injection, compression and extrusion processes; and can be solvent-welded, heat-sealed, and machined. The high strength and impact resistance of this material was demonstrated by driving a ¼-in. diameter Lexan "nail" through 5-ply wood by repeated hammer blows. Lexan has a notched izod impact strength of 14·0 ft.-lb. per in.; a heat distortion temperature of 285 deg. F.; and a water absorption figure of 0·3 per cent. For comparison, the corresponding figures for nylon are: 1·5 ft.-lb. per in.; 150 deg. F.; and 1·5 per cent., respectively. Lexan can be used for the manufacture of small gears, for clocks and office machinery, as it can be formed to close limits, and is totally resistant to the action of petroleum-based lubricating oils.

Quantity Production of Nails

The output of steel wire nails from the Castle Works, Cardiff, of Guest Keen & Nettlefolds (South Wales), Ltd., is one of the largest in the United Kingdom. The works, extending to many acres, are adjacent to the G.K.I.S. steel works and rolling mills where, among other activities, billets of a suitable type for nail manufacture are produced. The billets are rolled into rods at the G.K.N. (South Wales) Tremorfa Works, one of the most modern mills of its type in Europe. More than 250 sizes and types of nails are included in the G.K.N. standard list, ranging from round wire nails 12 in. long by ⅜ in. diameter, down to bright wire panel pins ½ in. long by 20 s.w.g. These nails, and many others of non-standard pattern, are produced in the Castle Works from 5 s.w.g. and larger diameter black rolled rod, which, after receipt in coil form, is subjected to a thorough cleansing process involving dipping in acid, rinsing, and lime baths, for the purpose of removing scale and other impurities from the surface.

Several coils, with a combined weight of 2 tons, are cleaned simultaneously after being picked up by a hair-pin hook, suspended from an overhead travelling crane which traverses the length of the cleaning bay. The load is immersed and agitated in a succession of hot solutions, the last of which contains a large proportion of lime. After being lifted from the lime bath, the coils rapidly lose surplus fluid by evaporation, and dry with a thin coating of lime over the entire cleaned surface of the wire. This deposit, in addition to its function as an acid neutralizing agent, serves to assist lubrication during subsequent wire drawing operations.

From the cleaning bay, the coils are moved by pole-trucks to the wire mill proper, where the diameter is reduced by a series of drawing operations. Each of these pole trucks has a short boom which can be inserted into loading arms of tubular construction for transport of the coils, and these arms are placed on stands adjacent to each wire drawing machine to facilitate feed of the rods into the dies. Wire is drawn through water-cooled tungsten carbide dies until its diameter is reduced to the required final dimensions.

Stock for the production of oval or square nails is produced by drawing round drawn wire between opposed profiled rolls of the requisite form. The nail making shop, part of which is shown in Fig. 1, is equipped with machines designed for high rates of production. The largest machines have an output of 150 nails per min. of maximum length and diameter of 10½ and ⅜ in., and the smallest, 620 nails per min. for sizes up to 1½ in. by 15 s.w.g. Wire is fed into the machines, gripped, headed, pointed and cut by side-acting tools, and the fully-shaped nails are ejected into bins. When filled, the bins are loaded on to a slow-moving slat conveyor, also shown in Fig. 1, which discharges at a weighing and checking station close to a Ransohoff nail cleaning plant. There are slight

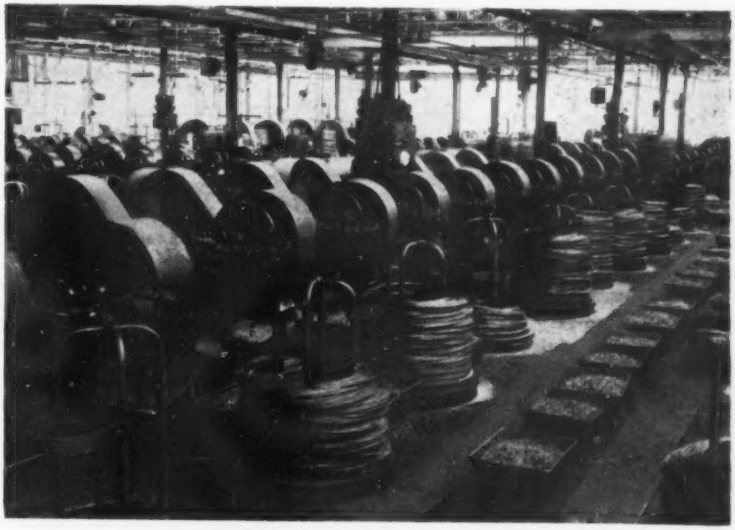


Fig. 1. A View Showing Nail Making Machines at the Castle Works of Guest Keen & Nettlefolds (South Wales), Ltd., Cardiff

limitations as regards the types of nails which can be handled by this plant. Very long, thin nails are not suitable for tumbling, and fine sizes will not pass the screens.

Occupying a floor space of approximately 1,600 sq. ft., the nail cleaning plant comprises four identical units arranged side by side as indicated in Fig. 2. Each unit comprises a dual storage hopper *A*, wet drum *B*, dry drum *C*, belt conveyor *D*, discharge pan, vibratory feeder, and automatic weighing machine. The hoppers, of 1-ton capacity, are loaded with nails and discharged at 20 min. intervals into the cleaning system, so that the capacity of the complete plant is 12 tons of nails per hour. During the process, all grease and dirt is removed from the nails, "nippings" from the nail points, carried over from the machine shop, are separated, and rough edges are smoothed.

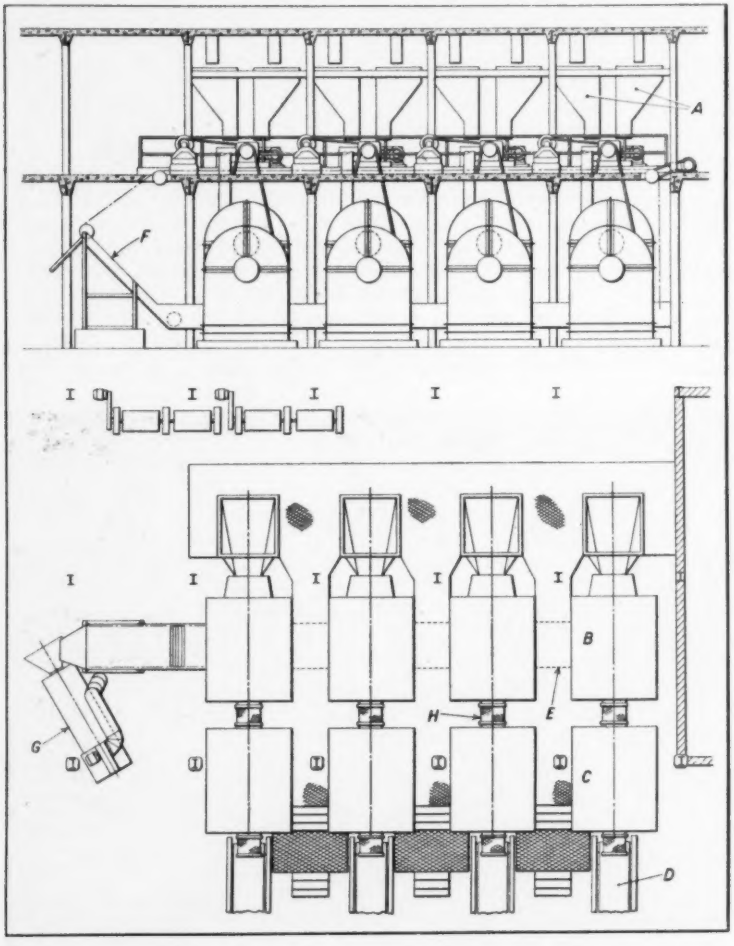


Fig. 2. Elevation and Plan Views of the Ransohoff Nail Cleaning Plant Showing the Principal Features

WET TREATMENT

From the weighing point at the end of the conveyor leading from the nail making shop, bins of nails are raised to the hopper-loading floor by an elevator and are automatically discharged at the higher level. The bins are then moved by hand along a roller conveyor to openings in the floor which are located above four dual hoppers, some of which are shown in Fig. 3. Each hopper is provided with a sluice-type gate which remains closed while the full charge of nails accumulates. At the beginning of a 20 min. cleaning cycle, the gate is opened by a rack and pinion arrangement under the control of an operator on the lower staging. Just before the charge is released from the hopper, a supply of hot alkaline degreasing fluid is pumped for 30 sec. into the rotating wet drum. Drain holes in the base permit this fluid to escape, but the process of draining is not completed for several minutes, and before it is far advanced, the operator admits the nails into the wet drum where they are washed and degreased by the fluid. This procedure ensures that all the fluid escapes during the time allowed for the wet tumbling operation, so that no surplus is carried over into the dry barrel. The spent fluid gravitates to a sump at ground level where it is kept hot by

a steam coil. A circulating pump, with an output of 200 gal. per min. against 25-ft. head, serves to distribute the fluid to all four wet drums, which are rotated at 20 r.p.m. through roller chain drives from reduction gearboxes mounted on the upper floor of the structure.

As the charge of nails gradually accumulates at the discharge end of the wet drum, it would tend to escape through the discharge orifice. This tendency is avoided by a special fitting in the form of a spiral plate which has the effect of reversing the flow of the contents at the point of discharge. The spiral has a lead of 10½ in. and an outside diameter of 24 in. "Nippings" from the nail points escape with surplus alkaline fluid through drain holes in the bottom of the wet drum, and fall into a long trough of rectangular section, seen at *E*, Fig. 2, which extends across the full width of the cleaning plant at ground level.

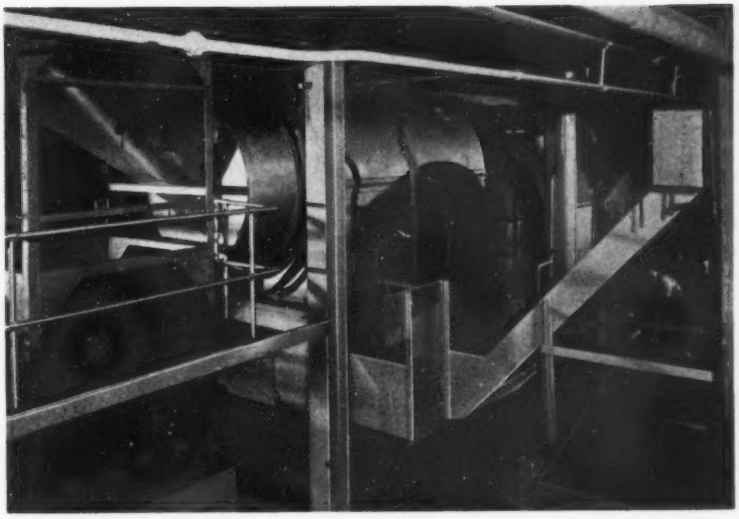


Fig. 3. A View of the Nail Hopper from which the Wet Drum of the Ransohoff Installation is Loaded

The fluid gravitates to a sump whence it is recirculated, but the solid matter is collected by the slats of a drag conveyor which extends along the bottom of the trough and encircles the whole plant in the form of a continuous loop. Accumulations of solids are carried, by the scraping action of the conveyor, to one end of the trough and up an incline *F* to a hopper, which discharges into a steam-heated rotary cylindrical screen *G*, 8 ft. long by 2 ft. diameter. Here, the residue is separated, by screening, into large and small nippings, and forms a useful by-product which is sold as shot for use in shot-blasting installations.

DRY RUMBLING

When the wet cleaning process has been completed, the nails are transferred to the dry rumbling barrel by the simple method of changing the direction of rotation of the wet drums from clockwise to anti-clockwise. This reversal of rotation causes the spiral plate at the delivery orifice, mentioned earlier, to assist the discharge of the contents by a scooping action in contrast to its previous restraining effect. Before entering the second drum, which, at this stage, is rotating at 20 r.p.m. in a clockwise direction, the charge of nails passes through a short horizontally-mounted cylindrical wire mesh screen *H*, whereby any "nippings" or metal fragments carried over from the first process are intercepted. Screenings fall into a bin, which is removed periodically and is emptied into the hopper of the shot-recovery plant already described.

The dry rumbling barrel is 8 ft. 6 in. long by 5 ft. 4 in. wide overall, and has ten flat sides made from ¾-in. thick mild steel plate welded together and held between two circular end plates. One of these plates has a flared intake, and the other a discharge orifice, in which is mounted a spiral plate, designed either to assist or prevent the discharge of the contents, according to the direction of rotation, as in the case of the wet drum. It may be mentioned here that although both wet and dry drums have similar mountings and driving mechanisms, the former is provided with a perforated lining concentric with the outer shell, whereas the latter has no inner portion. It is, however, provided with a number of 3-in. and 5-in. diameter stiffening members, in the form of mild steel tubes which branch radially from a central core of 5-in. diameter mild steel tube, and are welded at their outer ends to the sides of the drum. Apart from giving added rigidity to

the structure, these tubular members help to cause agitation of the contents, which hastens the polishing effect.

Trunnion-type mountings, which are fitted with chilled iron rollers running in double-sealed ball bearings, carry the weight of the drum and its contents. A sprocket, made up of segments, is bolted to a ring of ¾-in. thick mild steel welded to the wall of the drum. This sprocket is connected by a roller chain to an electrically-driven reduction gear. Rows of open gas jets, mounted horizontally beneath the drum, apply heat directly to the surface of the metal and provide sufficient warmth to drive off the bulk of the moisture from the contents. At one stage during the drying cycle, the operator pours approximately one bucketful of dry sawdust into the rotating drum through a small axial chute, to absorb excess moisture and grease particles. When drying has been completed, the drum is stopped and rotated in the reverse direction, whereupon the contents spill out through the delivery opening, aided by the spiral plate, and, as before, enter a cylindrical wire mesh screen. The nails pass along the screen and fall on to an inclined belt conveyor, but the sawdust, impregnated with dirt and moisture, falls through the screen mesh into a bin for disposal as waste.

WEIGHING AND PACKAGING

The short belt conveyor discharges into a large mechanically-operated shaker pan, which oscillates slowly backwards and forwards, and in so doing, distributes the full charge of nails, amounting to one ton in weight, over the entire bottom surface to an even depth. It also propels the nails, by its oscillatory action, through a tapered restriction to a discharge point, as illustrated in Fig. 4, which also shows the belt conveyor and shaker pans for the three remaining cleaning units of the installation. Immediately in front of the delivery from the shaker pan, there is an electrically-operated vibratory feeder, seen at the middle left, which delivers nails in a steady and controllable stream to the intake of an automatic weighing machine of the pre-set type. The weighing hopper of this unit has grab type jaws which remain closed until the required weight, in this instance 112 lb., has been admitted. When the hopper is fully loaded, the current supply to the vibratory feeder is interrupted so that the flow of nails is arrested. The jaws are opened by a hand lever and the contents discharged into an open sack held in a fixture below. The sack is immediately removed by the operator, and is sewn up rapidly by a sack sewing machine installed nearby. Meanwhile, the jaws of the weighing hopper are closed. Immediately the jaws close, the electrical circuit to the vibratory feeder is completed and the flow of nails towards the weighing machine is started again. Another sack is then placed under the hopper in readiness for the next load. This process is repeated, under the control of the operator, until the shaker pan has been emptied, by which time a further batch of nails is in progress.

An elaborate system of fume extraction, incorporating exhaust fans and branched trunking, part of which may be seen in Fig. 4, is installed. By means of this system, all fumes from the gas jets and alkaline solution, also dust produced in the dry drums and rotating screens, are removed from the plant, and satisfactory working conditions are provided for the operators.

A good proportion of the output of nails from this factory is exported to world markets which include the U.S.A. and Canada. Instead of the normal type of sack packaging for the home market, two-layer corrugated cardboard cartons, each holding 100 lb. of nails are employed for most export orders. The cartons are secured with steel tape by an automatic strapping machine shown in Fig. 5, which applies and fastens two steel tape bands on each package in two separate operations, the first of which has been completed in the illustration.

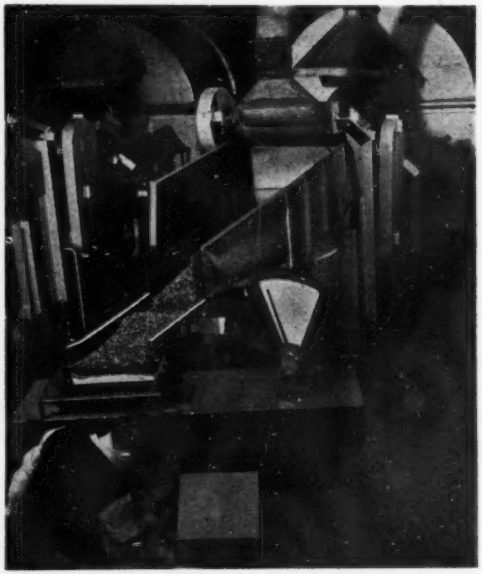


Fig. 4. Nails are Here Seen Emerging from the Shaker Pan and Passing into the Hopper of the Avery Weighing Machine

Fig. 5. For Export, Nails are Packed in Cartons which are Strapped on this Machine

Some users specify that nails should be supplied with a "cement" coating. The "cement" is a proprietary substance, resembling shellac. Black in colour and of a viscous nature, it is applied to a batch of nails in a 1-ton barrelling plant. During the process, the nails acquire a thin coating of the cement which enhances the holding power by 40 to 60 per cent.

About 10 per cent of the output of nails is galvanized. The plant employed for this process consists of a spelter granulating line, and twin, rotating barrel, galvanizing furnaces, which are fed with preweighed charges of nails, spelter and flux, through a system of skip hoists and hoppers. The galvanizing barrels are heated by external gas burners and are fitted with internal spiral guides, so that, by reversing the direction of rotation, the charge can be moved backwards and forwards along the barrel axis to ensure complete mixing. When the nails have been coated, the barrel doors are removed and the nails discharged, by reversal of the barrel, into a conveyor submerged in water. The galvanized nails are then fed automatically into a heated drying and tumbling barrel.

Ransohoff equipment for the surface treatment of metals includes drum-type washers, conveyor-type washing, rinsing and drying machines, pickling plant and a wide range of barrel finishing machines, all of which are distributed in this country by Roto-Finish Ltd., 39 Park Street, London, W.1.

Slot Milling Operations on Aircraft Joint Fittings

The illustration shows a set-up on a Cincinnati No. 4 horizontal milling, at the works of Boulton & Paul Aircraft, Ltd., Wolverhampton, for cutting deep slots in Comet tail plane joint fittings. These fittings are machined from forgings of S97 steel, with a tensile strength of 65 tons per sq. in., and the depth of the slots necessitates the use of 14-in. diameter high-speed steel cutters, which were supplied by Aldridge Tool & Engineering Co., Ltd., Aldridge, Nr. Walsall. The latter firm undertook the complete manufacture of the cutters, including machining, grinding and heat treatment.

To enable the spindle speed to be reduced sufficiently to provide for a surface speed of 33 ft. per min. with these large cutters, the machine has been fitted with a half-speed motor. A roughing cut of the full depth is taken with a feed of ¼ in. per min., and a finishing cut at ⅜ in. per min. Each cutter has 50 staggered teeth of 10-deg. alternate right- and left-hand helix angle, and the roughing cutter has corners chamfered at an angle of 60 deg. to the periphery. On the finishing cutter, the teeth have a ⅛-in. corner radius on each side.

Although the performance indicated was considered very satisfactory by the user, it is anticipated that it may be possible to obtain increased rates of metal removal on future batches of fittings.

Set-up for Milling Deep Slots in Steel Joint Fittings for Aircraft

Optically-controlled Filing Machine for Templates

A new method of making templates, which has been adopted at the Canton, Ohio, U.S.A., forging plant of Ford Motor Co., is reported to show savings in cost of as much as 50 per cent.

Large numbers of templates are employed at these works. In the die shop, undersize templates are provided for checking machining operations on forging dies, and full-size templates for the final polishing stages, on the bench. In the die inspection department, templates are used to check wear, and at the forging presses, work is checked with suitable templates while it is hot and after it has cooled, so that shrinkage may be determined.

In all, there are 8,000 templates, of which 3,000 are made or corrected yearly. All Ford forging production is concentrated at Canton, and as many as 600 of a particular die may be made in a year.

Templates are produced from ground gauge stock, from $\frac{1}{16}$ to $\frac{3}{8}$ in. thick, depending on the size. The thinner material is prehardened to 30 Rockwell C, to avoid distortion after machining. Distortion does not occur with the thicker templates, which are hardened after machining to 50 Rockwell C. Many of the larger templates used at the forging presses have knurled handles of steel, riveted to each end. With the previous method of template making, the gauge stock was blued and the required form laid out from the drawing. Rough stock removal was then carried out on a bandsaw and the form was then finished on a filing machine to the scribed outline. A careful inspection of all dimensions completed the operation. If the die required more than one template (as is usual), the same procedure had to be repeated. Frequently, the initial template became a master from which the other templates were laid out. This procedure was quicker than the alternative of laying out each one from the working of the die.

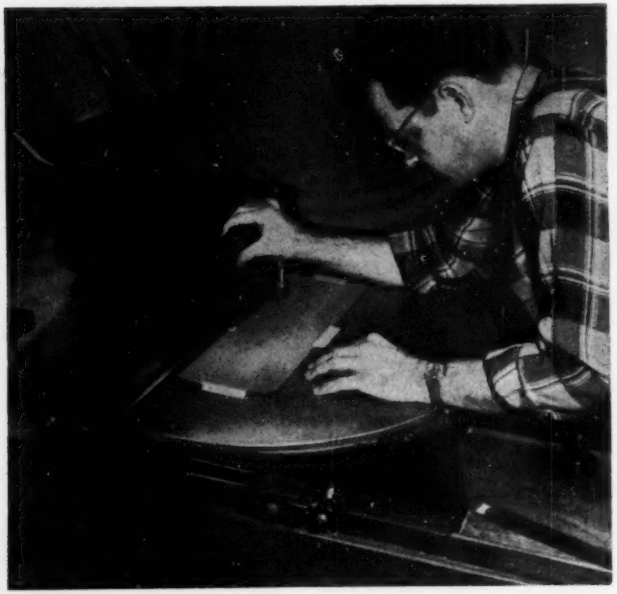


Fig. 1. With a Scriber Point, a 0·004-in. Wide Line is Cut Through the Emulsion Coating of the Reticle

By contrast, with the new method, the initial step is to lay out the form on a plastics-coated sheet known as a reticle. This operation is carried out on a Cincinnati Projecto-Form scribing machine as seen in Fig. 1. The reticle (Stabilene G 1334) is 0·0075 in. thick, and consists of a 0·0055-in. transparent Mylar base, with a 0·002-in. opaque-emulsion coating. It is secured to the machine table with masking tape.

Scribing is done with a carbide point of 30-deg. included angle, which cuts through the 0·002-in. coating, and produces lines 0·004 in. wide. The scriber is supported in a carriage which can slide across a vernier scale. In turn, this assembly can slide over a second vernier scale at 90 deg., so that accurate scriber movements can be obtained in co-ordinate directions. For scribing sloping lines, the table, which is circular, is rotated, its angular position being set with reference to a third vernier.

Next, the reticle is mounted on a

Fig. 2. The Operator Manipulates the Longitudinal and Transverse Feed Handwheels to File the Template to the Form of the Reticle

shadow box, and dimensions and arrowheads are scribed manually. At the same time, scribed lines are inspected with the aid of an optical scale. For all practical purposes, the reticle can now be regarded as a master template. It can be used repeatedly to make the steel working templates, and it can be stored readily in an ordinary file cabinet, where it occupies little space.

When a template is to be made, the reticle and the steel work-blank are positioned on the filing machine seen in Fig. 3, which was built by optical Gauging Products, Inc., Rochester, N.Y., U.S.A. Designed to permit the filing operation to be observed at a suitable magnification, the machine incorporates an optical projection system and a vertical filing mechanism. The work-blank is supported horizontally on a movable table. Approximately 12 in. above the table there is a glass plate on which the reticle is supported. The table can be moved longitudinally and transversely, so that the work can be guided against a small file which is mechanically reciprocated in the vertical plane.

Between the work-table and reticle is mounted a box containing a prism beam splitter. This device picks up the images of the work-blank and reticle, and directs them through the projection lenses in a housing at the rear. Images are presented at any desired magnification on a screen directly in front of the operator. In this particular instance, a 20× magnification is employed, so that the scribed lines on the reticle are projected with a width of 0·080 in. Since the reticle moves in unison with the work-blank, an optical system with a comparatively small screen provides for templates of large size (up to 6 in. wide and 20 in. long).

The table can be moved simultaneously, transversely, and longitudinally by means of two handwheels. Alternatively, a combination of automatic longitudinal feed with manual cross-feed can be applied. To follow a line scribed at an angle, the table can be swivelled up to 30 deg. in either direction. For filing radii, the feed movements are locked and the table is pivoted. Fig. 3 is a close-up view from the right-hand side of the

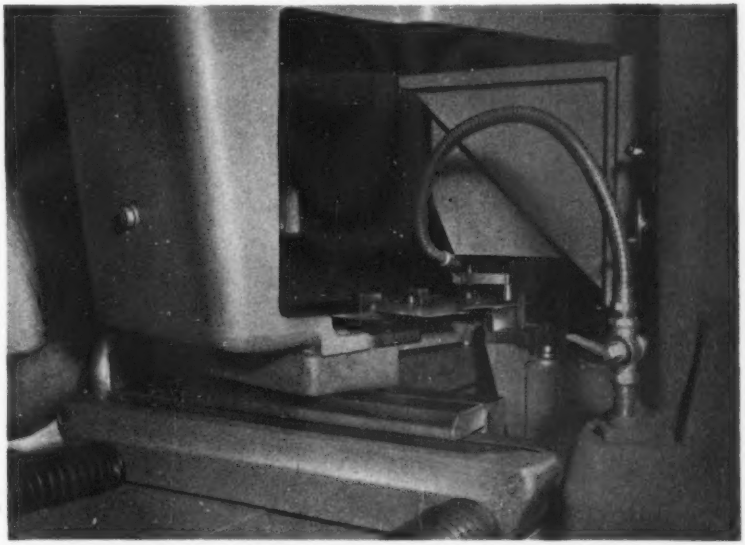


Fig. 3. This View, from the Side of the Machine, Shows a Radius Filing Operation in Progress. The File is Held in a C-frame with a Cylindrical Shank

machine, with a radius filing operation in progress.

No band-sawing is carried out with the new method. Instead, the profile is rapidly roughed out with a round file, and then finished with either a square file or a thin file. Each file is supported in a C-frame holder with a cylindrical shank which is held in a spring collet on the machine.

Approximately one-half of the templates that are required are now made from reticles on the optical filing machine. For a typical template, the total time for laying out, sawing, filing and inspection, with the former method, was 4·5 hours. Although the actual filing time with the new method is the same, savings at other stages enable the overall time to be reduced to 2·8 hours. Even more important economies are achieved when it is necessary to replace an existing template, since the work of laying out does not have to be repeated. With the original method, the time was the same as for the first template (4·5 hours), but for the new method it is only 1·8 hours.

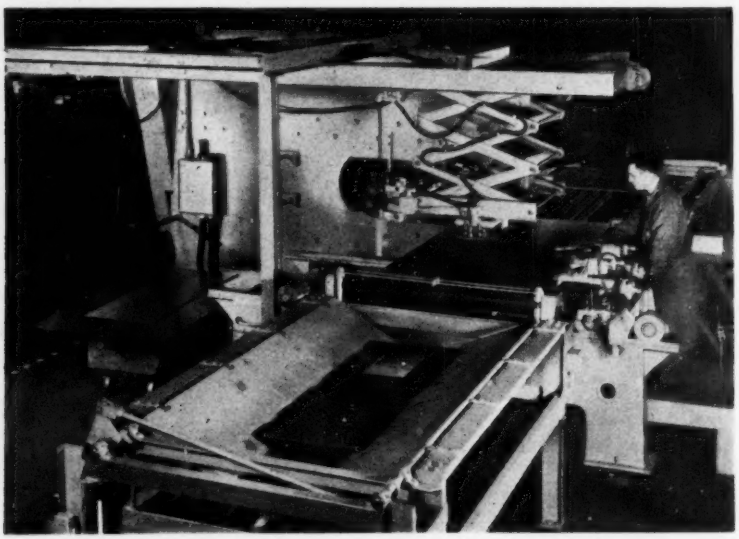
Another advantage of the new method is that it frequently enables a worn template to be salvaged, by refiling the edge to the form of the original reticle.

Wiedemann Turret Press with Automatic Work Handling Equipment

Built by the Wiedemann Machine Co., Philadelphia, Pa., U.S.A., the 40-ton turret press, here shown, incorporates automatic work handling equipment, and it set up for piercing openings for windows, knobs, strikers and hinges in 16 and 18 s.w.g. thick, sheet-metal panels for doors. The doors are of 2-piece sandwich construction, and are made in a variety of sizes.

A stack of sheet-metal blanks for door panels is carried by a trolley which is positioned at the side of the press. While piercing is being carried out on one panel, a fresh blank is lifted from the top of the stack by suction cups attached to "lazy tong" arms, which are next moved towards the front of the press on overhead guideways. Upon completion of the piercing operation the finished panel is discharged from the press and is passed to a stacking table at the left-hand side. The blank is then lowered on to a roller table under the control of the operator in readiness for piercing, whereupon the transfer unit is returned to its original position. Retractable rollers are provided for supporting the blank while it is being moved in the press from front to back, and the clamps and locating pins are air-operated. Co-ordinate positions of the work for the various piercing operations are selected by the operator with reference to a drum-type chart.

Wiedemann turret presses are now being built under license in this country on behalf of the selling agents, who are Dowding & Doll, Ltd., 346 Kensington High Street, London, W.14.



Wiedemann 40-ton Turret Press Fitted with Automatic Equipment for Handling Large Sheet-metal Blanks for the Production of Doors

Cutting Internal Gear Rings on a Liebherr Hobbing Machine

Hans Liebherr Maschinenfabrik, Hauptverwaltung, Biberach (Riss), W. Germany, have developed equipment for cutting large internal gear rings on their S.5 gear hobbing machines, and details of this equipment have now been made available through Sidney G. Jones, Ltd., 8 Balham Hill, London, S.W.12, who are their selling agents in this country. The equipment and method employed have been under development for the past two years at the Biberach works, and due to continual improvements in the design of cutters, the cutting speeds used have been steadily increased.

A general view of the two Liebherr machines employed for this work is given in Fig. 1, and it may be pointed out that, apart from certain modifications, which will be described, the machines are of normal design. The standard hobbing head of each machine has been removed, and has been replaced by a special milling unit as indicated at *A*. This unit consists of a cantilever bracket which slides on the normal hobbing-head guideways, and at the end of the cantilever arm there is an individually-driven cutter head. Bearings in the lower portion of this cutter head support each end of a horizontally - disposed spindle, and on the spindle, between the bearings, is mounted a disc-type cutter. The cutter spindle is driven by intermediate gearing from a horizontal layshaft, which is connected by V-belts to a motor, *B*. Each machine is arranged for hand-operated indexing of the work table, through the master worm and wormwheel. One tooth-space on the gear ring is cut at a time, and the table is rotated through the required angle before each actual cutting cycle. It has been found unnecessary to clamp the table in position during cutting. As may be seen from Fig. 1, the workpiece is secured, by means of multiple clamps, to a circular base which is mounted on the work table of the machine. The base is supported by rollers carried in adjustable jacks, mounted on the bed of the machine and on the floor alongside.

Fig. 2 is a close-up view of the cutter head of the machine seen in the foreground in Fig. 1. The cutter on this machine is of 250 mm. (9·84 in.) diameter, and has six carbide blades which are held in the cutter body by wedge-type clamps. Each blade is mounted so that it has zero radial angle and zero axial angle, but the blade has a clearance angle of 12 to 15 deg. all round the profile. The design of the cutter is such that alternate blades are employed for roughing and finishing.

The workpiece is made from case-hardening steel to the German specification C.45 (carbon, 0·42/0·50; silicon, 0·15/0·35; manganese, 0·5/0·8;

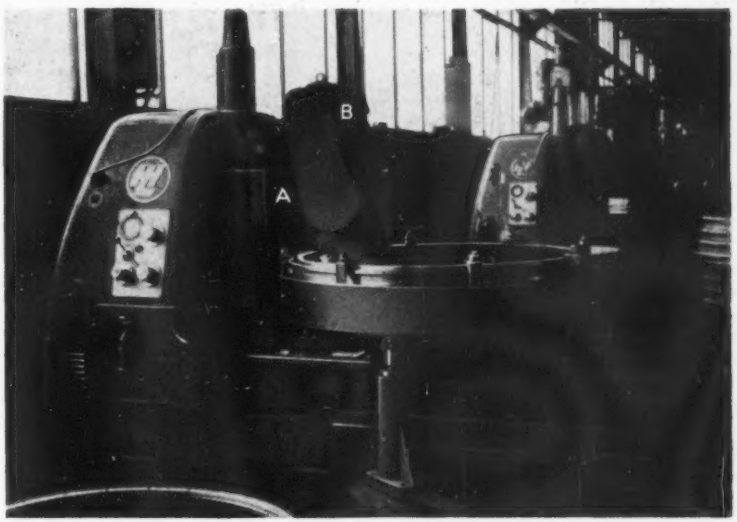


Fig. 1. A General View of the Two S.5 Gear Hobbing Machines Employed at the Liebherr Works for Cutting Internal Gear Teeth

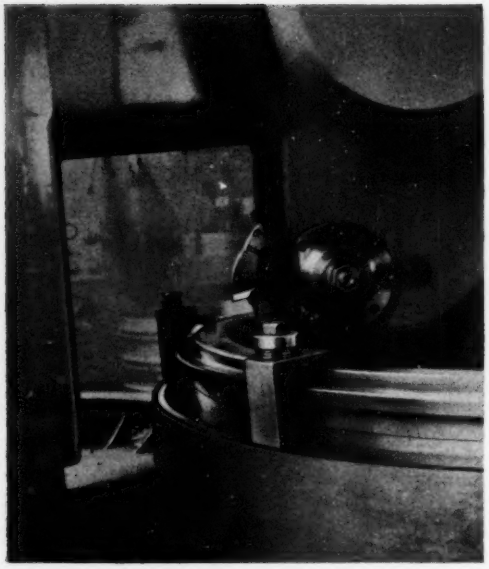


Fig. 2. Close-up View of the Cutter Head on One of the Specially-adapted Liebherr Machines

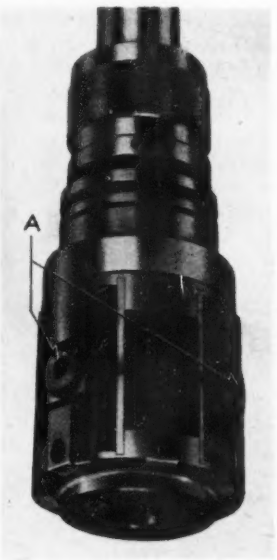
phosphorus and sulphur, 0·45 per cent). There are 164 internal teeth of No. 8 Module, and the face width of the workpiece is 70 mm. (2·756 in.). For machining the teeth, the cutter spindle is run at 550 r.p.m., and the resulting cutting speed is 1,414 ft. per min. The special head unit is moved downwards for cutting, and rapidly returned by means of the hydraulic traverse motion of the machine. For cutting, the feed rate is approximately 10 in. per min., and the rapid return traverse rate is approximately 50 in. per min. The actual cycle time required for each tooth, including indexing, cutting and rapid return, is 42 sec., and the average life of a cutter is 164 teeth (that is, one complete gear). The power absorbed in cutting is 7·7 h.p.

On the second machine, two workpieces are clamped one above the other so that the total face width is 115 mm. (4·528 in.). There are 140 teeth of No. 6 Module on each workpiece, and, again, the material is case-hardening steel of German specification C.45. The cutter employed for machining these workpieces is similar to that already described, except that it has only four teeth. This cutter is run at 440 r.p.m., to give a cutting speed of 1,132 ft. per min. The feed rate is 9·843 in. per min., and the rapid return traverse rate, 43·3 in. per min. The cycle time for machining one tooth on two gears, including the time for the return and indexing motions, is 61 sec. An average cutter life of 70 teeth (in each gear-ring) is obtained.

Barnesdril "Liquid Sizing" System for Gauging Honed Bores

A gauging system known as Liquid Sizing has been developed by the Barnes Drill Co., Rockford, Illinois, U.S.A., for checking workpiece bores during honing operations. Filtered coolant is fed by a constant-pressure variable-delivery pump through radially extending nozzles in the honing tool as indicated at *A* in this figure. At the same time, coolant is delivered to one side of a bellows at a pressure which is maintained at a constant value by two control orifices in the system. As honing proceeds, the pressure on the opposite side of the bellows, which is dependent upon the clearance between the nozzles and the workpiece bore, is reduced. In consequence, the bellows is permitted to expand, and when similar pressures are obtained on both sides a micro-switch is operated. This action causes a timer to be set, with the result that the spindle of the honing machine is reciprocated for one additional stroke. In the event of any portion of the bore being under-size, the micro-switch is again operated and honing proceeds. When the bore has been brought to the preset size for its entire length, the stones are retracted and the hone is brought clear of the work. The hone here shown is of the company's latest plate type.

The Barnes Drill Co., are represented in this country by Gaston E. Marbaix, Ltd., Devonshire House, Vicarage Crescent, London, S.W.11.



Barnesdril Plate Type Hone, with Nozzles for the "Liquid Sizing" Gauging System

Fig. 1. A General View of One of the Fabricating Bays at the Works of J. & H. McLaren, Ltd.

McLaren Fabrication Service

J. & H. McLaren, Ltd., Airedale Works, Leeds—a member company of the Hawker Siddeley Group—have for some years operated fabrication shops to provide welded steel fabricated structures for their own use and for other factories in the Brush Group. During the past two years, this service has been expanded, and fabrication capacity is now available for the engineering industry generally.

New equipment and greatly increased floor space have been provided, and structures of all sizes and types, with individual weights from a few pounds up to 15 tons, are produced in four shops, extending to more than 40,000 sq. ft., and the equipment is suitable for either large or small quantities.

Components range from air receivers, which are in quantity production for several customers, to cylinder housings for large diesel engines, large gearbox castings, condenser housings, production jigs for car bodies, bedplates, and stator frames for turbo-alternators. Fig. 1 shows a general view of one of the fabrication bays, and Fig. 2, a welded crankcase for a heavy Mirrlees, Bickerton & Day diesel engine.

The plate preparation department contains a battery of flame-cutting machines for plate up to 12 in. thick, together with a heavy-duty guillotine, power saws, rotary shears and plate-straightening equipment. In the plate bending and forming section, there is a large machine capable of forming and folding ½-in. plate up to 15 ft. long, and rolls which can handle plate 8 ft. wide by ½ in. thick

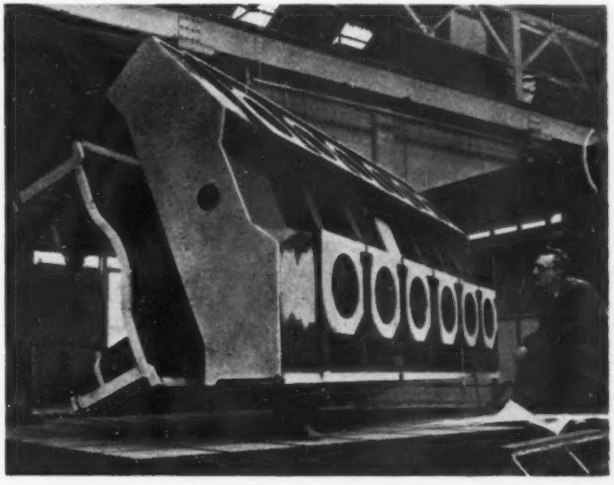


Fig. 2. A Welded Steel Crankcase Produced by J. & H. McLaren, Ltd., for a Large Mirrlees, Bickerton & Day Diesel Engine is Here Being Inspected

cold, and 2 ft. 6 in. by 1¼ in. hot. Heavy-duty pressing equipment is also available, and can be used for hot forming work such as air receiver ends with diameters up to 25 in.

A stress-relieving furnace, with automatic temperature control, is installed, which has a capacity of 4 ft. 3 in. by 7 ft. 6 in. by 25 ft. (in special cases, the 4-ft. 3-in. dimension can be increased to 6 ft.). In the near future, an automatic welding plant will be provided, also a new set of rolls, capable of rolling 8-ft. by ¾-in. plate cold, and 2-ft. 6-in. by 2-in. plate hot.

Equipment for Measuring the Torque-twist Characteristics of Fine Spring Wire

The U.S. National Bureau of Standards, on behalf of the U.S. Army Ordnance Corps, Springfield Armory, is at present investigating the effects of metallurgical variables on the properties of spring wire. Because the wire from which helical extension or compression springs is wound is stressed in torsion, a means was sought for measuring the torsional properties easily and accurately. For this purpose, equipment has been constructed which automatically records the torque-twist characteristics of wire of less than 0·05 in. diameter. Designed by Mr. H. C. Burnett and Mr. J. A. Bennett of the Bureau's mechanical metallurgy laboratory, this equipment incorporates a spark recording system which is entirely frictionless, so that even small torque values can be recorded accurately.

The framework of the equipment takes the form of a table with two shelves clamped to the legs. A small motor and reduction gear are mounted on the table surface. The length of wire to be tested—approximately 6½ in.—is suspended from a coupling attached to the output shaft of the reduction gear which extends through an opening in the table surface.

The lower end of the test wire passes through an opening in the middle shelf, and is coupled to a calibrated measuring wire which is of larger diameter than, and three times as long as, the sample. This measuring wire is held in a coupling keyed to the bottom shelf, and is spring loaded to provide a small amount of tension in both wires. To prevent oscillation, an inverted damping cup, immersed in a pan of light oil, is attached to the coupling at the bottom of the test wire.

A fixed helical electrode is mounted on the middle shelf. Located vertically within the fixed electrode there is a movable bar electrode, which is supported by the coupling between the two wires. A cylinder of heat-sensitive paper, on which the torque-twist measurements are recorded, is secured by tape to a disc attached to the coupling for the top of the test wire. This paper cylinder, which has suitable scales for torque and twist values, hangs suspended between the movable bar electrode and the fixed helical electrode, without touching either. Both the electrodes are of knife edge form, so that the point at which they are closest is accurately indicated by the spark.

In operation, the upper end of the test wire is rotated by the motor and reduction gear at an angular speed of about 100 deg. per min. At the same time, an interrupter and ignition coil produce sparks at 5-sec. intervals between the two electrodes, so that a line of small black dots is formed on the paper.

The angular deflection of the movable bar electrode is proportional to the torque applied to the measuring wire. This deflection displaces the position of the spark vertically on the paper by reason of the helical form of the fixed electrode. At the same time, the additional twist in the test wire causes rotation of the paper cylinder relative to the movable bar electrode, so that the position of the spark is displaced horizontally. Consequently, the dots on the paper record the torque-twist relationship of the test wire.

Equipment for Recording the Torque-twist Characteristics of Fine Spring Wire

Craven 60-in. Centre Lathe with Milling and Grinding Attachments

In Fig. 1 is shown a view of a 60-in. centre lathe, which has recently been built by Craven Brothers (Manchester), Ltd., Reddish, Stockport, for the Electricity Supply Commission—Rand Undertaking, South Africa. It is to be installed in the new central maintenance workshop at Rosherville power station, and will be used mainly for checking the truth of large electrical rotors and for carrying out light corrective operations on such components. In addition, it is suitable for general work of a light nature on shafting and large engine crankshafts; re-turning the journals and tyre treads of locomotive wheel sets; truing rotor shaft journals and parallel or tapered seatings for couplings, thrust collars, glands and turbine wheels; and the final skimming of the blade tips and shrouds of wheels which have been re-bladed. The lathe is not intended for very heavy cutting operations, but the bed and work stays must support rotors weighing up to 60 tons. Short lengths of thread can be re-cut for collars, and helical grooves for cooling purposes can be cut along the full length of a rotor body.

Work up to 45 ft. long is admitted between the centres, and up to 8 ft. 6 in. diameter can be swung over the saddle. The headstock is of comparatively light construction for a lathe of this capacity, and is mounted on a wide base which spans the full 9-ft. width of the 4-shear bed. Drive is taken from a 30-h.p. constant-speed motor, and there are 16 spindle speeds ranging from 1 to 50 r.p.m.

The saddle is mounted on the two front bedways and can be traversed past the work stays and the tailstock, which are mounted on the two rear bed-ways, so that operations can be performed on both ends of a rotor at one setting of the work. A normal transverse slide, fitted with a compound swivelling-type tool rest, is provided for the saddle. In addition, there is an intermediate slide, arranged for transverse adjustment by hand, to enable small diameters to be turned. Eight sliding feeds ranging from 0·0156 to 0·25 in., and eight surfacing feeds from 0·0078 to 0·125 in. per rev., are obtained by gear changes in the saddle apron, to which the feed drive is conveyed by a shaft along the front of the bed from a feed and screwcutting gearbox at the left-hand end.

As already indicated, screwcutting motion is available throughout the full turning length of the lathe and is provided by a leadscrew along the front of the bed, change wheels at the headstock enabling threads from 0·05- to 3-in. pitch to be cut. Rapid power traverse of the saddle on the bed is provided by a motor mounted on the apron. The swivel slide of the tool rest is of sufficient length to provide for a tool slide traverse of 30 in., and has both power feed and screwcutting motions.

Automatically-lubricated bronze bearings are

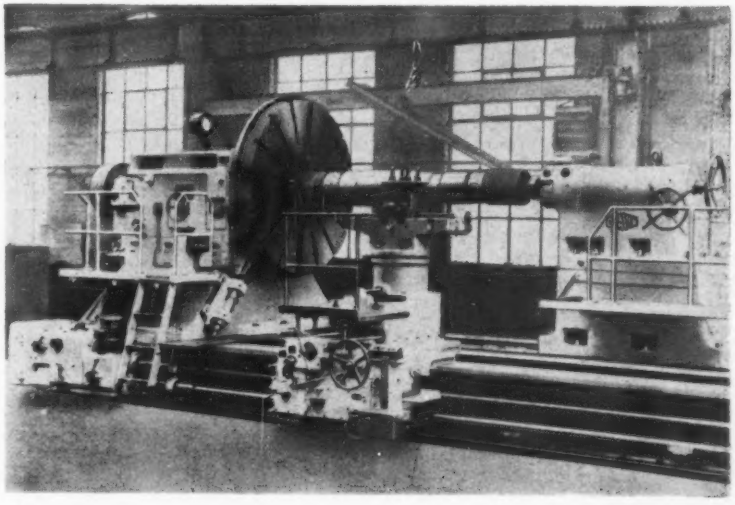


Fig. 1. Craven 60-in. Centre Lathe for Power Station Maintenance Work

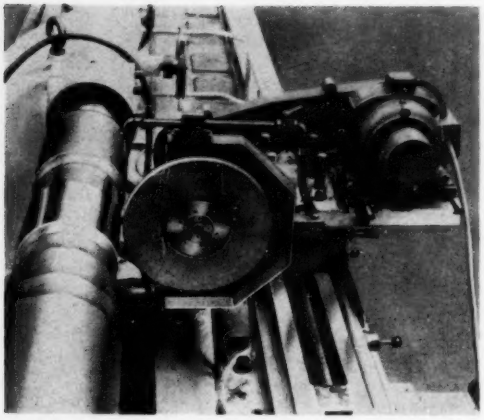


Fig. 2. Auxiliary Grinding Attachment Supplied for the Craven Lathe

provided for the headstock spindle, and all other shafts in the headstock run in ball and roller bearings. A 6-ft. diameter faceplate is mounted on the spindle nose, and has four independently-adjusted, built-in type, reversible steel jaws, capable of gripping work from 3½-in. to 5 ft. diameter. Angle graduations are marked around the periphery of the faceplate and a vernier scale is provided on the headstock for dividing, which is required mainly when cutting keyways with the auxiliary milling attachment. Provision is made for clamping the faceplate in any desired position during milling operations.

The tailstock is mounted on a deep sandwich plate, which spans the two rear ways of the bed, and is fitted with a cylindrical barrel with a fixed cone centre. An independent motor and rack pinion provide for power traverse along the bed. The headstock, tailstock and saddle are each provided with an elevated platform to facilitate operation. Electrical power is supplied to the saddle by armoured flexible multi-core cable wound on a spring-loaded cable drum, the cable being fully supported by a channel along the bed. Coolant is supplied by a motor-driven pump-unit, and is conveyed to the saddle by fixed piping extending along the bed and plug-in type flexible hose.

A self-contained auxiliary grinding head, as shown in Fig. 2, is supplied for bolting to the top of the normal tool slide, by means of the four tool clamping studs. The attachment has a 20-in. diameter abrasive wheel, driven by a 5-h.p. constant-speed motor, through V-belts, and is intended mainly for grinding rotor slip-rings from 12 to 28 in. diameter, and scored journals from 6 to 24 in. diameter. To permit of either right- or left-hand working, the spindle housing is made as a separate bracket which can be reversed bodily upon its base, so that the wheel may be on either side of the head, and a pulley is mounted at each end of the armature shaft of the motor. The normal saddle feeds along the bed can be employed for cylindrical grinding. Alternatively, the tool slide can be traversed on the swivel slide for grinding short tapers.

Arranged for mounting on the intermediate slide of the tool rest, after the normal swivel slide has been removed, is the self-contained milling attachment, shown at Fig. 3, which incorporates a top in-setting slide and swivel slide. The horizontal milling spindle is mounted in ball and roller bearings in a totally-enclosed head, driven by a 5-h.p. constant-speed motor. Three lever-operated gear changes in the head, in conjunction with slip change gears, give a total of six spindle speeds

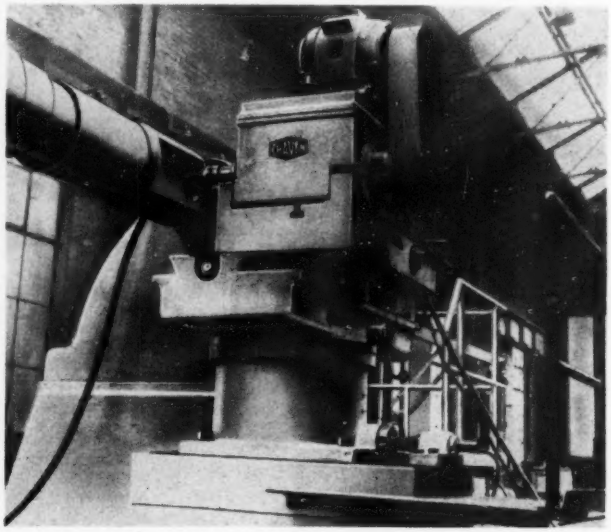


Fig. 3. Close-up View Showing the Auxiliary Milling Attachment Mounted on the Craven Lathe

for this attachment, ranging from 50 to 200 r.p.m.

The head is required to mill parallel or taper-seat keyways, up to 2½ in. wide in the ends of rotor shafts, or to clean out, for their full length, the wiring slots in rotor bodies. Hand-operated in-cutting adjustment of the intermediate transverse slide is provided, also power feed of the swivel slide on its long guide, which can be set to any required angle. A tilting arrangement in the mounting of the head provides a limited vertical adjustment for the accurate alignment of the milling spindle axis with that of the machine centres. An extension unit is available for bolting to the non-rotating body of the head, to provide a forward support bearing for cutters with extra long shanks or adapters. Keyway milling operations can then be carried out adjacent to deep shoulders or flanges.

During milling operations, the workpiece and the headstock spindle remain stationary. Feed motion is applied to the saddle along the bed, and to the milling head on the swivel slide, through the saddle apron gearing and the front feed shaft. As the latter cannot be driven from the headstock, however, it is disconnected, and is coupled to a separate 3 h.p. motor and worm reduction unit at the end of the bed, whereby a range of milling feeds in inches per min. is provided.

Three narrow steady rests, with wedge-type vertical adjustment, are provided to support rotors by their journals. Each stay has three interchangeable adapters, with bores of 12, 18 and 24 in. diameter, to which the customer can fit white-metal liners, to suit particular journal sizes. Two of the steadies have power traverse on the bed, and the third has hand adjustment only.

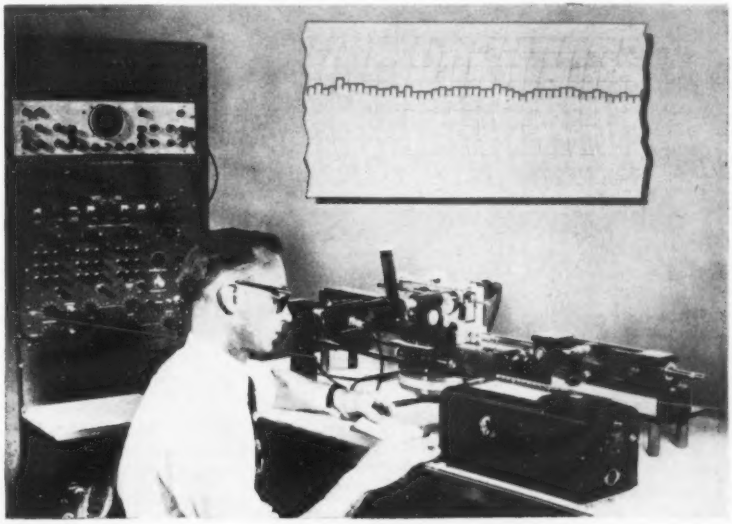
Accurate Pitch Measuring Equipment

The equipment shown in the figure has been developed by the Bell Telephone Laboratories, U.S.A., for rapidly measuring and recording small errors of pitch. It is at present being employed for checking travelling-wave tube helices, but is equally suitable for inspecting precision screws, grids, and ladder lines.

A part to be measured is rigidly mounted on a moving platform, which also carries a precision optical grating. This grating moves past a similar, fixed grating, and a beam of light is periodically interrupted. With this arrangement, a photo-cell is caused to produce electrical pulses representing accurate distance increments of 0·00004 in. Another fixed light beam and photo-cell combination produces an output pulse when an element of the "periodic structure" which is being checked passes a fixed point.

Pulses from the measuring scale and from the part which is under inspection are fed to an electronic computer whereby departures from nominal pitch are determined. This information is then recorded on a chart in such a manner as to provide a direct reading of the deviation of each "element."

It is stated that with this equipment a travelling-wave tube helix can be inspected in less than 5 min., whereas, with the previous method, the time required was more than two man-days.



Equipment for Accurately Measuring and Recording Pitch Errors. Information is Recorded on a Chart Similar to that Shown Inset

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Seventh Electrical Engineers' Exhibition

The seventh Electrical Engineers' Exhibition in the series organized by the Association of Supervising Electrical Engineers will be formally opened at Earl's Court, London, on March 25, by the Rt. Hon. Sir David Eccles, M.P., President of the Board of Trade, and will continue until the evening of March 29. From information already received, it is evident that a wide range of equipment will be displayed, and attention is here drawn to some items likely to be of particular interest to readers of MACHINERY.

General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2, will show 11-kV. substation equipment, comprising a ring main unit, a transformer, and medium-voltage, air-break switchgear, which is particularly intended for controlling current supplies in factories. The ring main unit consists of two hand-operated switches and a tee-off metal-clad oil circuit breaker. Attention may also be drawn to the company's new range of ventilated electric motors with class E insulation, which are available in sizes up to 50 h.p. with an operating speed of 3,000 r.p.m., and are made in accordance with the draft British Standard Specification CW/ELE/6246. The interchangeable end brackets can be fixed in four positions at 90 deg., so that the ventilation openings can be set downwards whether the motor is to be secured to a floor, wall or ceiling.

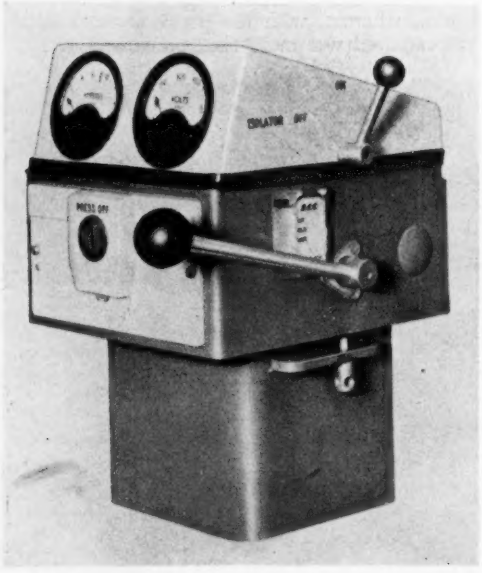


Fig. 1. G.E.C. 150-amp. Oil Circuit Breaker

The exhibits will also include star-delta and reversing starters, and recently-introduced vertical-lift contactors with ratings of 25 and 50 amp., which are intended for the remote control of motors, also heating and lighting equipment, by means of push buttons, pilot switches, time switches, and thermostats, for example. Another new product to be displayed is the 150-amp. oil circuit breaker illustrated in Fig. 1, which is representative of a range designed for the control and protection of low-power circuits, and for direct-to-line starting of squirrel-cage motors up to 60 h.p. Also of interest will be a heavy-duty control unit for an automatic chucking lathe with a 3-speed pole-change driving motor. In addition, under-floor ducting, an air conditioning unit and a Nightstor heater for installation in offices will be shown, together with examples of the company's wide range of lighting fittings.

A control desk which has been specially built for use with Babcock & Wilcox mechanical handling plant at the Chapel Cross atomic energy power station, will be exhibited by E.M.B. Co., Ltd., Moor Street, West Bromwich, Staffs. Push buttons are provided for starting the electric motors for the hydraulic variable speed drives to the hoist, travel, and traverse motions, and variations of the operating speeds are obtained by lever-operated hydraulic valves. A second exhibit will be a contactor control panel for the hoist motion of a 40-ton electric overhead travelling crane. Intended for operation with an 80-h.p. motor, this unit incorporates the company's MICROsem variable-speed control unit, and a drum-type master controller.

Taking part in the Electrical Engineers' Exhibition for the first time, Suffolk Iron Foundry (1920), Ltd., Stowmarket, Suffolk, will be displaying a full range of their welding and brazing equipment. Demonstration brazing of metal parts, with the company's Sifbronze filler materials in ring form, and Stanelco automatic electro-gas heating equipment supplied by Standard Telephones & Cables, Ltd. (Industrial Supplies Division), Footscray, Sidcup, East, will be carried out during the whole period of the exhibition.

As an indication of the increased production rates that can be obtained by the use of the methods to be demonstrated, it is reported that when a certain brazing operation was carried out on magneto armatures, about 400 components were handled per 8-hour shift, whereas with the Stanelco equipment and Sifbronze rings, 1,200 pieces can be brazed during the same period.

Made from stainless steel, the new Demon blow-pipe, to be exhibited, is of medium weight and is available with two nozzles for cutting metal up to 10 in. thick. The blow-pipe is intended to supplement the company's light- and heavy-duty types which incorporate a patent gas mixing device for preventing flash-back. Sifbronze regulators for gas welding, which will also be on view, are equipped with safety valves which are automatically brought into action in the event of a sudden rise in pressure.

Lancashire Dynamo Nevelin, Ltd., Hurst Green, Oxted, Surrey, will display their Varionic direct-to-mains, variable-speed drive system, which incorporates the recently-introduced Nevitron steel tube, single-anode, rectifier. Developed from the company's single-anode mercury-arc rectifier, with glass envelope, which was introduced some five years ago, the new steel tube unit is of more robust construction and can be supplied for larger outputs. Another new product to be shown is the monitored earth safety unit which is intended for the protection of operators using portable electric tools. The switchgear division of the company will show a new "load centre" switchboard, which incorporates all distribution and starting equipment for the control of a number of electric motors.

Among the exhibits of Square D, Ltd., 100 Aldersgate Street, London, E.C.1, may be noted the class 9050 narrow-base pneumatic timer, illustrated in Fig. 2, which has recently been introduced. Intended particularly for mounting on control panels for machine tools, this timer incorporates the various features of the types previously made by the company, but occupies 35 per cent less space. It is available in surface and flush mounting designs for use on A.C., and, for surface mounting only, for use on D.C. supplies. The timer for operation on A.C. supplies has a reversible magnet and guide assembly which can be set so that the time delay is obtained either before or after the magnet has been de-energized. The time delay can be varied steplessly from 0·2 sec. to 3 min., and an adjusting knob, with or without graduations for setting purposes, can be provided.

Another new product which will be exhibited by this company is a class 9001 type TP21R pilot lamp, which incorporates a separate electric circuit for testing the bulb, this operation being performed merely by depressing the coloured transparent cap. When the bulb is in the test position there is positive contact feel, and oil-tightness of the unit is maintained. All internal contacts are of silver-plated beryllium copper, and the use of wires has been avoided.

Fig. 2. The New "Square D" Narrow-base Pneumatic Timer

Attention may also be drawn to the recently-introduced class 8998 "control centres" which provide for centralized control of electric motors. Each assembly comprises a free-standing sheet metal frame with removable plug-in units, which contain load-break disconnect switches and starters. The starters may be of the single- or multi-speed, reversing or non-reversing types, for operation on line or reduced voltage, and may incorporate push buttons, pilot lamps, control transformers, and auxiliary switches. Units can readily be added to the assembly. Alternatively, blank sections can be provided in readiness for the installation of control gear which may be required in the future. Doors which give access to the electrical equipment are interlocked with the disconnect switches. In addition, there will be a representative selection from the company's extensive range of electric control gear, which finds numerous applications on machine tools.

Isopad, Ltd., Barnet By-Pass, Boreham Wood, Herts, will show examples of their electric surface heaters, and associated hand and automatic controlling equipment, which enable pre-set temperatures to be maintained accurately. Comprising

resistance heating elements interwoven with glass or quartz fibre yarn, these heaters are made in the form of flexible panels, jackets, mantles, pads and tapes, and are secured in position by means of straps or clips, and then lagged. Alternatively, the heating elements and lagging material can be supplied in a sheet metal cover, and when such heaters are to be used in explosive atmospheres, flame-proof glands and Buxton-certified junction boxes can be provided. Large heaters are made in several sections with independent control arrangements, and are readily secured to the equipment to be heated by means of bolts.

Heaters incorporating glass cloth can be operated at temperatures up to 400 deg. C, and those with quartz cloth, up to 800 deg. C. The power consumption may vary from 100 to 1,000 watts per sq. ft. Isopad heaters in tape form are made in lengths from 3 to 300 ft. and widths from 1 to 4 in., and seven different types will be on view ranging from high-temperature quartz tape to weather-proof tape which is intended to provide protection from frost for external pipe lines. These tapes may also be employed, for example, for heating pipes to ensure the free flow of highly viscous materials.

Several variable-speed electric motors and control systems will be exhibited on the stand of Laurence, Scott & Electromotors, Ltd., Norwich. For instance, one of the company's N-S variable speed A.C. motors, which are made in sizes from 1 to 12 h.p., will be demonstrated in conjunction with a hand-operated speed control system. Another working exhibit will comprise a 100/36-h.p. motor, with a direct-on-line starter, which will be arranged for remote control by push buttons and a pilot-motor operated induction regulator. The company's Asrec and Velonic control systems, which will also be demonstrated, are claimed to permit pre-set motor speeds to be maintained to a high degree of accuracy. In addition, the company's Revcon speed control system will be applied to a slip-ring train motor.

Another exhibit will be a variable-speed A.C. motor, of 860/57 h.p., which incorporates a heat-exchanger and is intended for driving the induced draught fan of 100-MW. generator set. Control equipment made by the company will be represented by a draw-out type unit which occupies a space of only 45 by 20 in., and incorporates starters for 15 squirrel-cage motors.

Squirrel-cage induction motors, with drip-proof enclosures, arranged for foot, flange, and skirt mounting, will be displayed by Crompton Parkinson, Ltd., Crompton House, Aldwych, London, W.C.2, as representative of their range which covers sizes from 1 to 50 h.p. Among fractional horse-power motors to be exhibited may be noted explosion-proof, geared, totally-enclosed, fan-cooled, and D.C. machines. Constant-reversal tests for evaluating heating, vibration and overload characteristics of a series "T" fractional horse-power motor will be demonstrated. Another working exhibit will incorporate the company's electric 3-phase tachometer and indicator, which can be operated at very slow speeds without needle flicker. An Airmec variable-speed electronic unit will be demonstrated, applied to a 1-h.p. motor.

A switchgear exhibit will take the form of a floor-mounted sheet-steel cubicle incorporating two flush type switch-fuse units and A.B.M. air circuit breakers, representative of a range with ratings up to 30 MVA. Examples from the company's latest range of industrial lighting units will be shown.

J. A. Crabtree & Co., Ltd., Lincoln Works, Walsall, Staffs, will show a comprehensive selection from their range of electric motor control equipment and wiring accessories. Of particular interest will be the new type F-60 miniature circuit breaker, which, it is claimed, is capable of breaking a fault current of 4,000 amp. at 250 volts A.C. The display will also include type D-6 hand-operated, type A-15 oil-break, and type B-15 air-break starters for electric motors, also flame-proof remote control equipment and limit switches with various operating arrangements.

In Fig. 3 is shown an example from an entirely new range of plug-in multi-contact relays, with transparent covers, which will be shown by

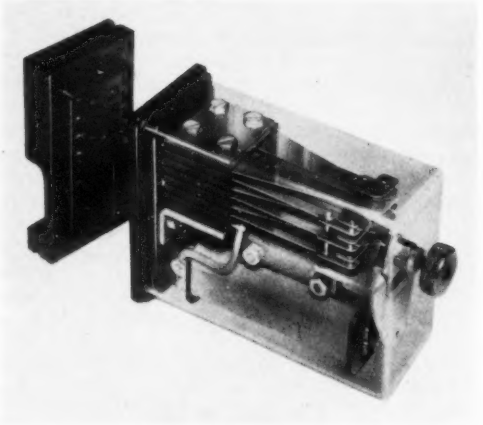


Fig. 3. An Example from the New Range of Robinson Plug-in Multi-contact Relays

D. Robinson & Co., 58 Oaks Avenue, Worcester Park, Surrey. Available for operation on A.C. or D.C. supplies, each relay occupies a space of about 1¼ by 2½ in., and the rating of the contacts is 2 amp. at 25 volts. The company's new plug-in mercury relays, which will also be displayed, are available with either two mercury switches, or a single switch and five pairs of silver contacts. A special lever system is incorporated which causes the switches to be moved through a greater angle than the armature. This feature permits the relays to be operated on a wide voltage range, and obviates the risk of the armature sticking. Measuring only 1 by 3 by 3¾ in., the new type J relay, which will be shown, is fitted with three change-over contacts, and has a rating of 3 amp. on A.C. supplies of 500 volts.

Small Electric Motors, Ltd., Churchfield Road, Beckenham, Kent, will exhibit D.C. and single- and 3-phase electric motors of the drip-proof, screen-protected, and totally-enclosed fan-cooled types, up to 10 h.p.; motors and speed control units for driving propeller fans from 12 to 24 in. diameter; and single and 3-phase machines up to 3 h.p., for air conditioning and heating and ventilating equipment. Electric motors for domestic appliances, gramophones, and recording machines will also be displayed, together with low-voltage, battery-operated motors up to 10 h.p. A single-phase ventilated motor to be shown has a totally-enclosed switch mechanism, and may be employed for purposes which would normally require totally-enclosed, fan-cooled machines. The display will also include single- and 3-phase alternators up to 6 kVA., and water pumps of special design with built-in driving motors.

The exhibits of Westinghouse Brake & Signal Co., Ltd., 82 York Way, Kings Cross, London, N.1, will draw attention to the extensive range of silicon, germanium, selenium and copper-oxide rectifiers, which are made by the company for a variety of applications. Electrical equipment incorporating silicon and germanium rectifiers will be demonstrated, and selenium and copper-oxide rectifiers of improved design will be on view.

A new product to be exhibited by Revo Electric Co., Ltd., Tipton, Staffs, is the electronic counter illustrated in Fig. 4. An unusual feature of this unit is that the count is displayed as a single row of ¾-in. high numerals, which can be read under normal lighting conditions at distances up to 25 ft. It has a maximum counting speed of 10 kilocycles per sec., and starting, stopping and re-setting of the instrument may be carried out by means of switches on the frame, or from a remote position. An electronic timer and a precision tachometer,

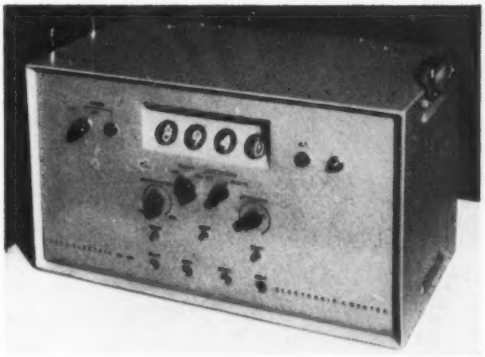


Fig. 4. Revo Electronic Counter

which have recently been added to the company's range of products, will also be displayed. Other exhibits will include a selection from the company's range of street lighting and industrial lighting equipment, Silvertip 30- and 60-amp. switchgear, and Safeway distribution fuse boards.

The Heenatone programme control unit, which will be demonstrated by Heenan & Froude, Ltd., Worcester, enables a number of operations or movements to be automatically started in accordance with a pre-selected sequence. Depression of push-buttons, which correspond to the various operations or movements, causes tones of different frequencies to be recorded on a magnetic tape by an electronic frequency generator. These tones are subsequently identified by a frequency selector unit, which operates a number of contactors for starting the movements or operations. The unit may be employed, for example, for the automatic control of a variable-speed drive system. Magnetic tapes can be conveniently stored in readiness for future use, and any particular programme can be readily erased when a fresh sequence of tones is to be recorded.

A selection from the company's range of air-cooled slip couplings for transmitting drives up to 100 h.p., at constant torque, will be displayed, together with a water-cooled coupling of a type which is available in various sizes for transmitting up to 600 h.p. There will also be a number of electronic control units which provide D.C. excitation for couplings from A.C. mains, and can be arranged to provide drives with various characteristics, to suit different applications. The Heenatron drive system, to be demonstrated, incorporates an electronically-controlled D.C. motor with a wide range of operating speeds, which can be closely controlled.

Fig. 5. The Frequency Selector for the Heenatone Programme Control Unit

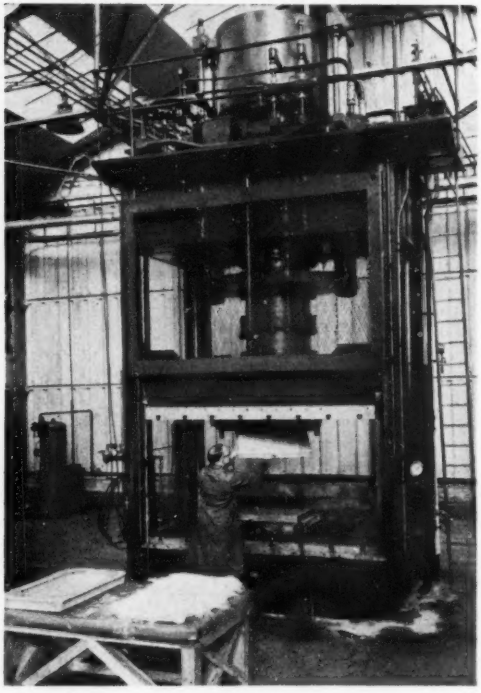
Another exhibit, the Heenan-Dynamatic Mk.1 dynamometer, is the smallest of a range of eight units, which find numerous applications for the testing of engines, turbines, electric motors, and vehicle transmission systems. An important feature of the unit is that the electronic control system can be arranged to give a wide range of torque/speed characteristics.

Turner Brothers Asbestos Co.

Under a £4,000,000 development programme, announced in 1947, Turner Brothers Asbestos Co., Ltd., Rochdale, have established a new factory on a 140-acre site at Hindley Green, near Wigan, Lancs. This location was chosen, on the recommendation of the Board of Trade, to help to avoid the severe unemployment which has previously occurred at intervals in the area. The factory will eventually provide work for nearly 2,000 people and comprises two blocks of buildings with a total floor area of 1,000,000 sq. ft.

The North block, which was finished in 1949, is devoted to the manufacture of transmission and conveyor belts in a variety of types and materials, for many different industries. Motor-vehicle fan belts which were previously made at the Chapel-en-le-Frith factory of Ferodo, Ltd., an associated company, are being produced with plant installed in this block.

More recently completed, the South block is now being brought into use and is devoted to the manufacture of asbestos textiles, mainly for brake linings; glass fibre textiles; and the resinated asbestos moulding material known as Durestos, which is used for making aircraft drop tanks, for example. Moulding of plastics reinforced with glass and asbestos fibres is already being undertaken on an experimental basis, on presses such as the oil-hydraulic unit here illustrated, which was supplied by T. H. & J. Daniels, Ltd., Stroud, Glos. The male former is heated to about 120 deg. C., and a moulding pressure of some 100 lb. per sq. in. is employed to produce the baker's tray, which can be seen being removed from the press. The filler employed is the company's Duramat non-woven chopped glass fabric.



Daniels Plastics Moulding Press Installed at the New Hindley Green Works of Turner Brothers Asbestos Co., Ltd.

The Sparcard Hard-surfacing Process

Impregnated Diamond Products, Ltd., Tuffley Crescent, Gloucester, who, for some years, have been producing spark-machining equipment, which is marketed under the name Sparcatron, found, during the course of research in this field, that under certain electrical conditions there was a transfer of material from the tool electrode to the workpiece. In solving this problem, the reason for the phenomenon was discovered, and it was found possible to exaggerate the condition, so that the process can be employed to provide a very hard surface layer to tool tips and other parts which are subjected to severe wear in service. It is claimed that when this treatment is applied to high-speed steel, the advantages of toughness and comparatively low cost, which this material offers, are combined with a high degree of surface hardness and wear resistance.

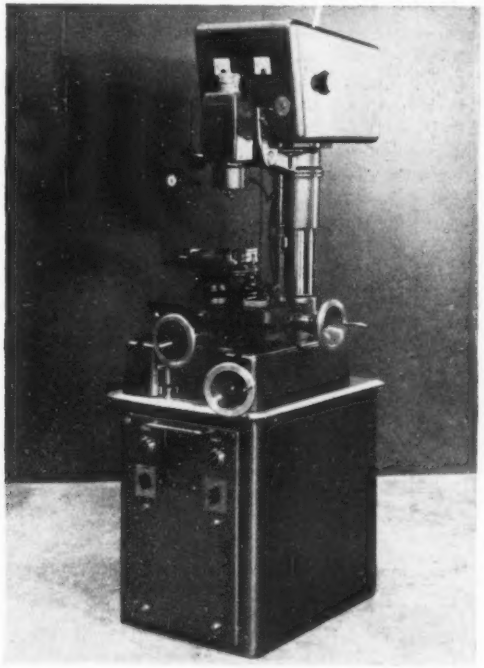


Fig. 1. The Sparcard Machine for Hard-surfacing Tools and Various Components by the Spark Process

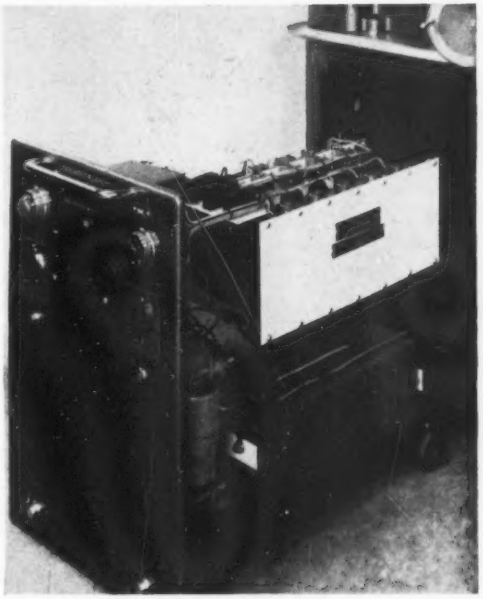


Fig. 2. The Transformer and Power Supply Equipment are Mounted on a Trolley which can Readily be Withdrawn from the Base of the Machine

For this new process, to which the name Sparcard has been applied, the electrical circuit is very similar to that employed on the Sparcatron machine, and the principal difference between the Sparcard machine, shown in Fig. 1, and the spark machining equipment is that a vibrator has been substituted for the servo head. The cabinet base of the machine houses the transformer and power supply equipment, which are carried on a trolley and can readily be withdrawn for servicing, as seen in Fig. 2. In the head of the machine are housed the condensers and the output side of the circuit, and it is also equipped with a voltmeter, an ammeter, and switches for controlling the spark discharge. Mounted beneath the head, the vibrator is provided with a clamp for holding the electrode, which is usually of tungsten carbide. Coarse adjustment is provided by a handwheel, and there is a micrometer depth control for fine adjustment of the electrode when the machine is

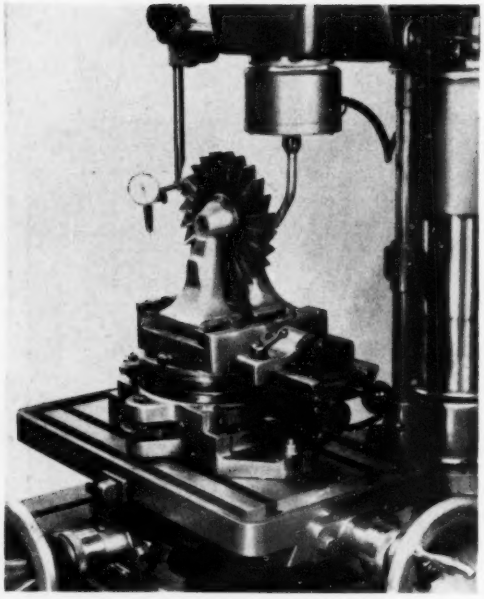


Fig. 3. A Close-up View Showing a Milling Cutter Set Up for Treatment on the Sparcard Machine

in operation. The head is carried on a column and can be swung aside for convenience when setting up the work, and locked securely in the operating position.

A T-slotted surface on the base carries a compound slide which provides longitudinal and transverse movements of 12 and 6½ in. by handwheels. As seen in Fig. 3, a universal holder is provided which will take single-point tools, reamers, and milling cutters up to 8 in. diameter.

The work surface, which should previously have been ground, must be free from dirt, oil or grease. With the tool or other component mounted in the holder, the electrode is brought into contact with it, the current is switched on, and the surface that required to be treated is then traversed beneath the electrode.

Spark discharge is regulated by means of a rheostat, with reference to the ammeter and voltmeter, so that a constant condition is maintained. There are four settings for condenser power, and tools can be suitably treated for heavy, medium, and fine finishing operations. An intense blue spark is formed in the air gap between the electrode and the work, and the operator should wear dark glasses to afford protection to his eyes.

Treatment is applied to the tool face which will be subjected to the most severe wearing conditions in service, and normally to the top rake surface to prevent erosion by the chip. When flank wear is heavy, however, it may be advisable to treat this area. It is stated that compensation can be made for minor irregularities of the work surface, by adjusting the amplitude of vibrator oscillation.

The makers of the machine report that they have treated a large number of tool and other work surfaces for various companies, including an aircraft manufacturer who has found that the spark-hardening of certain components offers very great advantages. In addition, extensive field trials have been carried out by well known firms. It is pointed out that, whereas the process was developed primarily for application to tools, it can also be employed to increase the wear resistance of a variety of parts.

Treated surfaces closely resemble those which have been spark-machined. They are composed of many shallow craters and have a satin appearance. Photomicrographs show that the craters are lined with hard metal, and that the hardening effect penetrates deeply into the sub-surface zone. It is stated that, when tool steel is treated, a sandwich effect is produced. Beneath the hardened surface and immediate sub-surface zones there is a softer zone, and below that the parent metal.

A treatment shop has been set up at the works of Impregnated Diamond Products, Ltd., where samples can be processed for subsequent testing by prospective customers. There is also a school where operators can be trained in the use of both Sparcard and Sparcatron machines.

Problems of Working High Temperature-resistant Materials

(*Continued from page* 639)

and the process is said to offer particular advantages when employed for finishing thin sections which would be liable to warp if more orthodox machining methods were employed.

There is no doubt that as temperature-resistant materials are increasingly specified for the structural parts of aircraft and missiles, the difficulties of the production departments will be multiplied. It is essential, therefore, that all new methods which show promise should be fully developed and exploited, and that intensive research should be directed to the discovery of better solutions for many of the problems that will arise.

News of the Industry

Glasgow and District

CLYDESIDE SHIPYARDS and marine engine building shops still have a very large volume of orders in hand, although during recent months there has been a decided falling-off in the rate at which new business has been placed, and the same applies to ship repair work. Iron and steel production continues at a high level, and the makers of electrical plant, coal-mining machinery, structural steelwork and all types of cranes are busy. Machine tool makers are working to capacity and there is a particularly strong demand for the heavier types of equipment. American-controlled factories on the various industrial estates are steadily increasing their labour forces to enable outputs to be expanded.

JOHN LANG & SONS, LTD., Johnstone, are fully occupied with the production of standard centre, and surfacing and boring lathes, for both home and overseas customers. Centre lathes in progress range from 13- to 36-in. swing capacity, and surfacing and boring lathes from 17- to 48-in. swing. The principal export markets are Australia, South Africa and Canada. We may also note that lathes equipped with profiling attachments for both turning and facing are in hand, and an oil country lathe is on order for South America.

CLIFTON & BAIRD, LTD., Johnstone, are busy with the production of their standard range of front-cutting type, heavy-duty, high-speed cold metal sawing machines, equipped with saws from 18 to 44 in. diameter. Vertical sawing machines and automatic saw sharpeners of various sizes are also in good request. Other work includes two rail milling and drilling machines, which are destined for Spain, and rotary end-milling machines up to 63 in. diameter capacity for structural steelworks. Machines for export to Australia are in progress. The latest addition to the plant is an Archdale 4-ft. radial drilling machine.

SCOTTISH MACHINE TOOL CORPORATION, LTD., 17, Lynedoch Crescent, Charing Cross, Glasgow, have a big programme of home and overseas machine tool orders in hand at the works of the member firms, namely, Craig & Donald, Ltd., Loudon Bros, Ltd., G. & A. Harvey, Ltd., and James Bennie & Sons, Ltd.

CRAIG & DONALD, LTD., Johnstone, have a considerable variety of machine tools in progress for shipyards, steel fabrication works, electrical plant and motor vehicle producers, and some of them are destined for Canada, Spain and Israel. We may note hydraulic press brakes, with automatic control, of 120-, 200-, and 400-ton capacities. The latter will handle 10-ft. wide by ⅝-in. thick plates, and we hope, shortly, to make further reference to it. Hydraulic guillotine shears of 8-ft. by ¼-in. and 10-ft. by ½-in. capacities are on order, and folding machines range up to 13-ft. by ⅝-in. plate capacity. In the latter category we may note a recently-completed universal machine for 10-ft. wide by 1-in. thick plates. Other work includes the full range of section ring curving machines, plate bending rolls from 6-ft. by ¼-in. up to 8-ft. by ½-in. capacity, and rotary shearing machines.

LOUDON BROS., LTD., Johnstone, are experiencing a good demand for railway carriage and wagon wheel lathes and double-standard and openside-type planing machines. Double-column planing machines in progress range up to 20 by 7 ft. square and openside-types up to 15 by 5 ft. square. We hope shortly to describe a 40- by 9- by 8¼-ft. planing machine which has recently been supplied to the British Polar Engine Co., Ltd., for machining diesel engine bedplates. It is equipped for cross-, deep-, and radius-planing. Other orders cover two rail planing machines, a 15- by 12-ft. horizontal and vertical wall-type planing machine, a column-type horizontal and vertical planing machine, and 24-in. centre screwcutting lathes to admit 30 ft. between centres. The latest addition to plant is a Denham 15-in. centre lathe.

G. & A. HARVEY, LTD., Glasgow, have orders in hand for single- and two-point open-fronted and straight-sided power presses, ranging from 100 to 400 tons capacity. We may note the recent completion of a batch of six, 425-ton, knuckle-joint type power presses for bicycle manufacture. In addition, orders are in hand for a 21-in. centre lathe to admit 24 ft. between centres, a 24-in. centre lathe to admit 30 ft. between centres, boring and facing lathes to swing 6 and 8 ft. diameter, and a 3-in. spindle horizontal drilling and boring machine. We hope, in the near future, to describe a 50-ton, 24-station, turret punching press which has recently been completed at these works.

JAMES BENNIE & SONS, LTD., Glasgow, have recently completed the largest set of plate straightening rolls yet built, for Harland & Wolff, Ltd., Belfast. Of the 7-roller type, the machine

has a capacity for 11 ft. wide by 2 in. thick plates, and we hope to describe it in due course. Plate bending and straightening rolls, plate edge planing machines up to 40 ft. long for 2-in. plates and 25 ft. long for 1½-in. plates, rotary shears, and combination punching and shearing machines are all in good request. Both mechanical and hydraulic type guillotine shearing machines are on order up to 10-ft. by 1-in. capacity, and other work includes beam bending machines and a one-man punching table. There is a lively demand for the firm's cold-type hydraulic ships' frame bending machines for 17-in. channels, and orders have recently been received from Holland, Germany, Sweden, Norway, Spain, Australia and Canada. Orders are also in hand for a smaller machine of this type for dealing with 12-in. channels. The latest addition to the plant is a Klopp (Wickman, Ltd.) 16-in. stroke hydraulic slotting machine, and an additional 25-ton electric overhead travelling crane, by John Smith (Keighley), Ltd., has been installed.

H. B.

Productivity Conference

The British Productivity Council, 21 Tothill Street, London, S.W.1, has organized a conference which will be held in conjunction with the Factory Equipment Exhibition from April 14 to 16. The themes will be "productivity and efficiency with a high bank rate" and "cutting costs for productivity," and the subjects of the various sessions will be as follows: work study and production control; costing; variety reduction and quality control; shift work; and "the team approach." Full particulars and application forms can be obtained from the above address.

Coming Events

ROYAL STATISTICAL SOCIETY.—*Leicester Group.* March 27, at 7 p.m., in Room 104, Leicester College of Technology, The Newarke, Leicester; paper on "Methods of Productivity Measurements," by Dr. T. E. Easterfield.

INSTITUTION OF MECHANICAL ENGINEERS.—*Southern Graduates' Section.* March 26, at 7.30 p.m., at Southampton Technical College; paper on "The Application of Electronics to Mechanical Engineering," by R. J. Miles.

INSTITUTION OF PRODUCTION ENGINEERS.—*Lincoln Section.* March 27, at 7.30 p.m., at the Ruston Club, Lincoln; the +G.F.+ film on Copy Turning. *Preston Section.* March 28, at 7.30 p.m., at the Technical College, Abbey Road, Barrow-in-Furness; lecture on "The Electronic Control of Machine Tools," by D. T. N. Williamson. *Rochester Graduate Section.* March 27, at 7.30 p.m., at the Old Palace, Maidstone, Kent; lecture on "Philosophy of Incentives." *Cardiff Section.* March 28, at 7 p.m., at the South Wales Institute of Engineers, Park Place, Cardiff; lecture on "Nylon—A New Engineering Material," by T. W. Currie.

JUNIOR INSTITUTION OF ENGINEERS. March 28, at 7 p.m., at the Institution, Pepys House, 14 Rochester Row, Westminster, London, S.W.1; paper on "Photo-copying and the Drawing Office," by G. V. Rickards.

Conference on Compressed Air

A conference on "Improving Productivity by the Use of Compressed Air," organized by the Cornwall Section of the Institution of Production Engineers, will be held at the Cornwall Technical College, Camborne, on April 9 and 10. Full particulars and application forms can be obtained from The Secretary, The Institution of Production Engineers, 10 Chesterfield Street, London, W.1. The opening address will be given by The Rt. Hon. The Earl of Halsbury, F.R.I.C., F.Inst.P., M.I.Prod.E., and papers on the following subjects will be presented: industrial uses of rotary compressors; fire and explosion hazards in compressed air systems; air gauging; a user's experience; and air operated equipment. Some recent films concerned with applications of compressed air will be shown.

Production Engineering Course

The Imperial College of Science and Technology, Mechanical Engineering Department, South Kensington, London, S.W.7, have established a post-graduate course in production engineering, which is intended mainly for graduates who have spent a period in industry. This full-time course is of one year's duration, starting in October, and successful candidates will be awarded the D.I.C. It is hoped that it will help to solve the problem of the rather long period necessary for training the junior executive on the production side.

In addition to production engineering, the subjects include industrial engineering, industrial materials, industrial applications of statistics, and industrial administration. It is a condition of the award of the D.I.C. that the student should submit a dissertation on an industrial or technological problem. Applications for admission to the course should be made to the Registrar at the above address.

Computer Conference Postponed

It was announced in MACHINERY 92/690—21/3/58 that a conference on Electronic Digital Computers and their industrial applications, with particular reference to Ferranti computers would be held by the Birmingham College of Technology at Gosta Green on March 26. We are informed that owing to unavoidable circumstances, it has been necessary to postpone this conference until the autumn.

Correction

In the article on the E.I.A. Group Apprenticeship Training Scheme, which appeared in MACHINERY 92/625—14/3/58, the name of the company operating the scheme was given incorrectly. The name is Industrial Administration (R & A), Ltd.

Bryant & May Engineering Works

Bryant & May, Ltd., have considerable engineering facilities for the overhaul, development, and modification of machinery. Indeed, the company, together with its associates and subsidiaries, is among the larger users of machine tools in this country.

As part of a current programme of match factory modernization in London, Liverpool, and Glasgow, the Central Engineering Works, Old Ford Road, Bow, London, E.3, has been built, equipped, and brought into use during the past year. Of prefabricated concrete construction, and erected by Beecham Buildings, Ltd., Shipston-on-Stour, Warwickshire, the premises house a machine shop and a fitting shop which cover a total floor area of 15,000 sq. ft.

In addition, there are electric- and gas-welding, heat-treatment, inspection, and stores departments, also offices.

Among the machine tools noted during a recent visit were Dean, Smith & Grace, Harrison, Holbrook, Lang, and Swift lathes, with centre heights from 4 to 12 in.; a Herbert 2D capstan lathe; milling machines by Adcock & Shipley, Cincinnati, Cunliffe & Croom, Graffenstaden, and Huron; and a Pfauter machine, with tangential attachment, for hobbing gears up to 29 in. diameter and 1 d.p. Mention may also be made of a Waldrich Coburg hydraulic planing machine with a capacity for parts up to 96 by 33 by 27 in.; a 20-in. stroke Butler hydraulic shaper; a 7-in. stroke Burdett toolroom slotter; and small Bliss and Marlco presses. Equipment in the drilling and boring sections includes type V, H, and C Herbert drilling machines, an Asquith O.D.3 radial drilling and boring machine, and a Wotan horizontal borer with a spindle traverse of 27 in. and cross and longitudinal table movements of 29½ and 48 in. Among the grinding machines installed are Churchill 30-in. universal and surface types, an Abwood 25- by 10-in. surface grinder which admits work up to 10½ in. high under the wheel, a Hunt twist-drill grinder, and a Cincinnati No. 2 tool and cutter grinder. In addition, delivery is expected shortly of a Keller copy milling machine and a Société Genevoise Hydroptic 6A jig boring and milling machine.

A Jones & Shipman universal grinder which had just been re-conditioned in these works was noted, also an "Abrasive" surface grinder, recently brought in from another of the organization's factories for re-conditioning.

A general view in the machine shop is shown in the accompanying illustration. To the left of this shop is the fitting bay, where a large match machine was seen undergoing modifications to improve its performance. Both machine and fitting shops are served by overhead cranes with pendant floor controls. At present, there are 52 skilled operators and fitters and 8 apprentices at the works. The apprentices are released from their duties for a whole day during each week so that they may receive suitable instruction at technical colleges.

A General View in the Machine Shop at the Central Engineering Works of Bryant & May, Ltd., Old Ford Road, London, E.3.

Industrial Notes

ELGAR MACHINE TOOL CO., LTD., 172-178 Victoria Road, Acton, London, W.3, have been appointed sole distributors for the range of centreless grinding machines made by the Italian firm Ghiringhelli & Pisoni.

BASTIAN & ALLEN, LTD., inform us that their Midland Counties office has been moved to 71 Broad Street, Birmingham, 15 (telephone number, Midland 7995), and their Yorkshire and Lincolnshire office to 22 Ullswater Road, Bennett Lane, Dewsbury, Yorks.

AN AUCTION SALE OF MACHINE TOOLS and miscellaneous equipment will be held at the M.O.S. Storage Depot, Royal Arsenal, Woolwich, London, S.E.18, on April 15 to 17. The auctioneers will be Fuller, Horsey, Sons & Cassell (Dept. N.), 10 Lloyd's Avenue, London, E.C.3.

FIRTH CLEVELAND STEEL STRIP, LTD., Locarno Road, Tipton, Staffs., inform us that the trade mark Fircleve has been accepted by the Registrar of Trade Marks as applicable to their range of cold-rolled steel strip and flattened wire, and cold-rolled hardened and tempered steel strip and flattened wire.

THE ASSOCIATION OF ENGINEERING DISTRIBUTORS, Hastings House, 10 Norfolk Street, London, W.C.2, has issued a booklet to indicate "what it is, what it does, and how it does it." Information is included on qualification for membership, subscription rates, and products covered by the various sections. Applications for membership are invited.

THE EXPORT CREDITS GUARANTEE DEPARTMENT announces that its office in the City of London has been moved to larger premises at Marlon House, Mark Lane, E.C.3 (telephone number, Royal 3491). The Nottingham office will move, on March 25, to Lloyds Bank Chambers, Old Market Square (telephone number, Nottingham 46585).

THE FEDERATION OF ENGINEERING DESIGN CONSULTANTS, St. Stephens House, Westminster, London, S.W.1, have decided to hold a sales promotional conference at the Leofric Hotel, Coventry, on March 27. The object of the conference is to investigate present demands for design consultancy and to examine the possibilities of new outlets in engineering fields. These outlets, it is suggested, have, until recently, been neglected because of the sustained demand for design work in the jig and tool industries, notably those serving the aircraft industry.

THE 13TH INSTRUMENT-AUTOMATION CONFERENCE AND EXHIBITION is to be held in the Philadelphia Convention Hall, U.S.A., from September 15 to 19. At the corresponding event in 1957, which was staged in Cleveland, there were more than 400 exhibitors, and the attendance was 19,000. Intending exhibitors should communicate with Mr. Fred J. Tabery, Exhibit Manager, Instrument Society of America, 3443 South Hill Street, Los Angeles, 17, California. Further particulars can be obtained from the Export Publicity and Fairs Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1.

PLANT FOR MAKING GAS FROM LOW-GRADE COAL.—Low-grade open-cast coal will be fed by conveyor belt directly from a National Coal Board site into a £6,500,000 gas plant which is to be built for the Scottish Gas Board at Westfield, near Loch Leven. For the first time in Britain, the Lurgi pressure gasification process will be used to enable gas to be made from low-grade coal unsuitable for normal carbonizing plant. When completed, the plant will have a capacity of 30 million cu. ft. of gas per day. At an interim stage, involving an expenditure of £4 million, the output will be 15 million cu. ft. per day.

AT THE MATERIALS HANDLING CONVENTION which is to be held in conjunction with the Mechanical Handling Exhibition at Earls Court from May 8 to 16, the subjects of papers will include: some handling problems in the motor industry; the application of mobile equipment in power stations; focusing the materials handling target; and automation and mechanization—their effect on labour relations. Tickets, which will also admit the holders to the exhibition, can be obtained free, on application to Mr. H. A. Collman, *Mechanical Handling*, Dorset House, Stamford Street, London, S.E.1.

WILLIAM JESSOP & SONS, LTD., Brightside Works, Sheffield, 6, are shortly to install a consumable electrode arc-melting furnace which, it is stated, will be the largest of its kind in Europe. The new plant will be employed for the manufacture of Vacumelt steels and Hylite titanium alloys, and will treble the company's production capacity for these materials. It will also permit the production of ingots up to 24 in. diameter and 3 tons in weight. The furnace, which is being imported from Western Germany, will have fully automatic control, and safety arrangements have received special attention.

TIN RESEARCH INSTITUTE, Fraser Road, Greenford, Middlesex.—The annual report of the Institute for 1957 extends to 36 pages, and includes a number of illustrations. Sections are devoted, for example, to the staff of the Institute, the 25th anniversary, conferences and lectures, exhibitions, films, technical enquiries, and student apprentices. Under the heading "current research," notes are given on a number of subjects, among which may be mentioned hot-tinning, soldering, electroplating, powder metallurgy of tin, tin-titanium alloys, aluminium tin bearings, continuous casting, tin in cast iron, and properties of tin alloys at low temperatures.

AN INTERNATIONAL APPRENTICE COMPETITION will be held in Brussels in July during the International Exhibition. The governing body, with headquarters in Spain, is the Organizing Committee of the International Vocational Training Competition and there is a British Organizing Committee. The following are among the trades in which apprentices will compete: metal fitting, turning, milling and forging, electric welding, oxy-acetylene welding, and pattern making. Firms wishing to submit the names of boys for possible inclusion in the British team should write to: Director (A.C.), City and Guilds of London Institute, Gresham College, Basinghall Street, London, E.C.2.

Northern Aluminium Expansion

Northern Aluminium Co., Ltd., the principal fabricating subsidiary of Aluminium, Ltd., plan to spend £10,000,000 over the next four years, nearly £8,000,000 of which will be devoted to new plant and buildings. The major part of this programme will be concerned with expansion of the company's aluminium rolling mill at Rogerstone, Monmouthshire. Here the annual capacity will be raised to 75,000 tons, in such a way that a further increase will be possible—at a relatively low cost per ton—to an ultimate figure of 175,000 tons. The remainder of the investment will provide for further modernization of the Banbury and Birmingham works.

The principal additions to the plant at Rogerstone will include a 12 ft. wide hot mill for breaking-down ingots and rolling large plate; the addition of a third stand to the present 2-stand hot-finishing mill, with provision for a fourth; and the introduction of hot coiling under tension direct from this mill. Preheating, annealing and re-melting furnaces will be among the auxiliary equipment installed to serve the new "hot line," and cold-rolling facilities will also be augmented. In addition, there will be a 4,000-ton stretcher for stress-relieving and flattening plate, a plate heat-treatment furnace, a high-speed plate saw for accurate finishing, and apparatus for ultrasonically testing the internal soundness of thick plate.

Scrap Metals

†LONDON.—‡Prices per ton for non-ferrous scrap metals free from iron are as follows:—clean copper wire, untinned and free from lead and solder, £130; clean heavy copper, untinned and free from lead and solder, £123; second grade copper wire, £117; clean light copper £114; braziery copper, £106; gunmetal, £112; brass mixed, £74; lead, net, £58; zinc, £25; cast aluminium, £91; old rolled aluminium, £124; battery lead, £31; unsweated brass radiators, £61; hollow pewter, £495; black pewter, £365.

MIDLANDS.—The movement of all ferrous scrap is very restricted as consumers' stocks are still at a record level, and allocations from steelworks are curtailed. Problems of clearance are many, and the following grades present the greatest difficulty as haulage and storage of light scrap is expensive: bushy turnings, light iron, destructor scrap, and light steel. Prices offered by merchants for these grades have eased considerably, although consumers still pay the maximum prices for the small tonnages that they are accepting. The many loads of chipped turnings that are forthcoming in this area are being placed with blast furnaces, and only very small quantities of turnings are being bought by steelworks as No. 9 quality, at the higher price.

Stocks of hydraulically compressed destructor bales are increasing all over the Midlands and Southern Counties and merchants (although they are selling below the control maximum prices in some cases) need more outlets if the loose scrap produced in the area is to be collected regularly. Large tonnages of scrap from military depots, government sites, etc., are on offer, but many merchants, with yards fully stocked with regular production scrap, cannot consider even quoting for such extraneous material.

All deliveries of short heavy steel to foundries are on an allocation basis, and merchants are finding difficulty in disposing of all the sheared scrap available.

It is a very difficult period for merchants handling production scrap from local factories, where daily clearance is essential. Until more markets are available they are forced to reduce their prices, to allow for storage of scrap and additional haulage charges.

With steelworks, blast furnaces, and foundries only accepting limited deliveries, buyers have become even more selective as regards the acceptance of scrap, and great care is being taken at present by suppliers to ensure that all loadings are strictly to specification.

Current maximum control prices, delivered consumers' works, are now: *Heavy steel No. 1, 217s. 6d.; *heavy steel No. 2, 196s.; *heavy steel No. 4, 207s. 6d.; *heavy steel No. 5, 195s. 6d.; light iron No. 8, 149s.; short turnings No. 9 (free from alloy), 167s. 3d.; light steel No. 11, 164s. 3d.; bushy turnings, 117s.; short alloy turnings, 160s. 9d.; short steel No. 2, 233s. 3d.; machinery cast, 233s.

Prices may be increased up to 2s. 6d. per ton according to quantities tendered over a given period.

* For use by Round Oak Steelworks, Brierley Hill, increase by 1s. 6d. per ton.
† George Cohen, Sons & Co., Ltd., Commercial Road, E.14.
‡ Subject to market fluctuations.

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21/3/58

BRITISH MACHINE TOOL

Exports of New Machine Tools

Countries	Vertical Boring Machines		Other Boring Machines		Drilling Machines		Grinding, Lapping and Honing Machines		Automatic Lathes		Capstan and Turret Lathes		Other Lathes		Screwing Machines	
	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £
Commonwealth																
South Africa	250 (1)	7,480	—	—	819 (17)	18,351	613 (95)	18,743	63 (2)	2,471	212 (4)	7,733	1,969 (33)	63,090	—	—
India	—	—	57 (2)	2,623	627 (18)	19,969	622 (85)	16,913	138 (1)	9,220	788 (15)	28,096	436 (24)	15,239	118 (7)	6,632
Pakistan	—	—	2 (1)	150	4 (2)	187	46 (12)	2,037	869 (13)	46,539	—	—	358 (6)	4,877	20 (1)	999
Australia	5 (1)	157	867 (14)	31,233	592 (43)	18,548	407 (16)	15,308	—	—	850 (30)	31,315	674 (49)	21,583	276 (8)	17,020
New Zealand	—	—	94 (1)	5,306	182 (10)	3,788	62 (93)	3,140	29 (2)	2,203	25 (1)	863	199 (12)	6,201	—	—
Canada	125 (1)	2,896	150 (1)	2,915	1,428 (31)	28,500	325 (16)	13,678	—	—	263 (5)	11,000	522 (15)	14,425	—	—
Miscellaneous	—	—	7 (4)	581	439 (50)	8,384	288 (42)	10,102	98 (2)	3,369	44 (4)	2,158	1,322 (45)	34,946	113 (13)	3,631
Foreign																
Soviet Union	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sweden	—	—	—	—	169 (5)	3,732	55 (5)	1,726	—	—	87 (4)	2,791	17 (1)	704	—	—
Norway	120 (1)	3,150	—	—	153 (4)	3,675	45 (3)	1,258	—	—	—	—	29 (7)	969	—	—
Denmark	—	—	23 (3)	537	—	—	41 (2)	1,184	36 (1)	1,945	—	—	18 (1)	520	—	—
Western Germany	—	—	—	—	—	—	112 (7)	5,768	—	—	24 (1)	175	50 (6)	1,757	—	—
Netherlands	125 (1)	3,317	2 (1)	287	33 (13)	1,023	92 (2)	2,440	—	—	163 (5)	5,686	52 (26)	1,789	31 (1)	2,485
Belgium	—	—	—	—	48 (4)	1,581	25 (15)	1,472	56 (1)	2,367	115 (2)	5,254	21 (1)	625	—	—
France	—	—	—	—	—	—	635 (11)	30,679	—	—	70 (1)	2,730	42 (2)	1,169	—	—
Switzerland	128 (1)	3,795	—	—	196 (6)	5,574	19 (2)	873	—	—	29 (1)	1,654	—	—	—	—
Spain	—	—	—	—	425 (4)	16,131	847 (8)	37,188	35 (1)	3,279	51 (1)	1,875	—	—	21 (1)	2,588
Italy	2 (1)	287	2 (1)	287	—	—	77 (3)	1,724	290 (2)	15,041	—	—	—	—	—	—
U.S. America	212 (2)	7,121	—	—	861 (13)	17,799	308 (24)	16,251	331 (8)	13,743	533 (9)	26,475	1,755 (73)	45,976	—	—
Miscellaneous	2 (1)	165	106 (2)	5,505	532 (89)	14,226	1,123 (50)	41,761	214 (3)	6,800	49 (8)	2,364	956 (68)	30,974	—	—
Total	969 (10)	28,368	1,310 (30)	49,424	6,508 (309)	161,468	5,742 (491)	222,245	2,159 (36)	106,977	3,303 (91)	130,169	8,420 (369)	244,844	579 (31)	33,355
Amendments to previous accounts																
Commonwealth	—	—	—	—	+14 (+5)	+368	−23 (—)	−129	—	—	—	—	+9 (+2)	—	—	—
Foreign	—	—	—	—	—	—	+25 (+4)	+1,355	−62 (−3)	+469	—	−1,900	+105 (+4)	+2,826	−20 (−1)	−2,344

Total exports of reconditioned machine tools: No., 60; Weight, 3,441 cwt.; Value, £48,909.
Total exports of imported machine tools: No., 17; Weight, 596 cwt.; Value, £18,677.

Imports of New Machine Tools

Country of Origin	Boring and Broaching Machines		Drilling Machines		Gear-cutting Machines		Grinding, Lapping and Honing Machines		Automatic Lathes	
	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £
Western Germany	1,690 (10)	48,790	58 (10)	5,393	63 (6)	4,861	1,231 (28)	49,393	802 (31)	45,925
Belgium	289 (2)	10,850	—	—	—	—	—	—	54 (1)	2,292
France	—	—	—	—	—	—	59 (1)	4,215	190 (4)	10,849
Switzerland	1,096 (9)	77,178	145 (4)	2,974	51 (9)	6,699	354 (18)	33,432	782 (22)	57,111
U.S. America	—	—	84 (5)	13,482	—	—	678 (8)	39,508	147 (4)	11,046
Miscellaneous	981 (7)	26,451	98 (7)	1,517	72 (1)	1,683	492 (17)	24,298	277 (4)	14,564
Total	4,056 (28)	163,269	385 (26)	23,366	186 (16)	13,243	2,814 (72)	150,846	2,252 (66)	141,787
Amendments to previous accounts										
Western Germany	—	−56	—	—	—	—	−3 (—)	−20	—	—
Belgium	—	—	—	—	—	—	—	—	—	—
Switzerland	—	—	—	—	—	—	—	—	—	−27
U.S. America	—	—	—	—	—	—	—	—	—	—
Miscellaneous	—	—	—	—	—	—	—	—	—	—

Total imports of reconditioned machine tools: Quantity: No., 23; Weight, 1,299 cwt.; Value, £21,208.

IMPORTS AND EXPORTS (Classified)

and Parts during December, 1957

Threading Machines		Milling Machines		Gear-cutting Machines		Planing, Shaping and Slotting Machines		Presses		Sheet Metal-working Machines		Sawing Machines		Other Machines		Machine Tool Parts*		Total	
Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt.	Value £	Quantity. Cwt. and No.	Value £
—	—	33 (1)	2,013	—	—	—	—	118 (3)	3,431	47 (14)	3,472	76 (7)	2,033	279 (29)	6,222	144	6,312	4,623 (206)	141,351
—	—	408 (9)	18,288	—	—	4 (1)	191	873 (8)	15,846	616 (6)	12,427	25 (4)	844	901 (19)	32,208	172	13,076	5,785 (199)	191,572
—	—	—	—	—	—	138 (1)	2,290	257 (7)	11,113	—	—	1 (1)	26	81 (4)	5,277	2	239	1,778 (48)	73,734
86 (5)	5,446	830 (19)	41,508	—	—	166 (8)	3,153	6,662 (73)	122,186	126 (53)	2,238	248 (1)	6,471	102 (53)	4,102	488	37,680	12,379 (373)	357,948
8 (3)	290	51 (2)	3,148	—	—	87 (21)	1,940	97 (4)	3,691	1 (1)	52	12 (2)	260	59 (8)	2,441	80	2,759	966 (160)	36,082
—	—	106 (5)	4,201	—	—	468 (12)	9,249	245 (2)	4,158	60 (2)	1,482	146 (14)	2,743	57 (2)	1,136	814	9,105	4,709 (106)	105,488
—	—	246 (6)	9,070	14 (1)	777	204 (10)	4,144	193 (7)	5,375	170 (15)	3,359	73 (9)	1,782	443 (37)	7,852	122	6,434	3,776 (245)	101,964
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	375 (2)	10,500	—	—	—	—	874 (1)	17,920	57 (1)	5,354	—	—	39 (3)	1,526	53	3,633	1,726 (22)	47,886
—	—	35 (1)	2,167	—	—	18 (1)	329	37 (2)	668	—	—	—	—	55 (4)	2,889	4	624	496 (23)	15,729
—	—	—	—	—	—	26 (1)	880	—	—	—	—	—	—	1 (1)	97	7	481	152 (9)	5,644
—	—	—	—	—	—	—	—	11 (1)	1,959	—	—	—	—	150 (3)	6,133	2,627	50,434	2,974 (18)	66,226
—	—	8 (1)	380	—	—	—	—	399 (3)	13,257	12 (4)	637	5 (1)	490	514 (3)	8,435	59	3,443	1,495 (61)	43,669
—	—	—	—	67 (1)	3,407	37 (1)	2,018	—	—	—	—	91 (1)	1,667	121 (19)	6,073	112	8,588	693 (45)	33,052
—	—	72 (1)	2,600	—	—	—	—	255 (3)	9,907	310 (1)	12,484	—	—	1,255 (10)	39,571	71	5,972	2,710 (29)	105,112
—	—	400 (6)	20,637	714 (1)	18,272	—	—	496 (1)	10,065	—	—	—	—	264 (5)	15,446	30	2,345	2,276 (23)	78,661
—	—	400 (2)	13,978	360 (1)	21,377	283 (3)	12,229	1,020 (1)	17,909	—	—	—	—	—	—	8	726	3,450 (22)	127,280
—	—	—	—	—	—	—	—	1 (1)	185	—	—	—	—	209 (6)	25,226	77	1,858	658 (14)	44,608
—	—	1,653 (1)	33,163	27 (1)	4,302	1,845 (3)	23,853	200 (4)	6,794	23 (26)	274	35 (1)	558	358 (5)	9,661	197	23,472	8,338 (170)	229,442
115 (5)	14,435	314 (9)	14,551	72 (3)	3,725	537 (22)	13,462	128 (8)	2,603	178 (43)	5,846	124 (8)	3,091	1,048 (92)	27,332	532	22,322	6,030 (411)	209,162
209 (13)	20,171	4,931 (65)	176,204	1,254 (8)	51,860	3,813 (84)	73,738	11,866 (129)	247,067	1,600 (166)	47,625	836 (49)	19,965	5,936 (303)	201,627	5,579	199,503	65,014 (2184)	2,014,610
—	—	+67 (+1)	+2,554	—	—	+230 (+2)	+5,359	+200 (+1)	+3,150	+335 (+2)	+7,850	+13 (+1)	+449	−46 (−)	−8,790	−149	−12983	—	—
+69 (−)	—	−97 (−)	—	+90 (+1)	+4,707	−51 (−)	—	+120 (−)	+2,506	— (+8)	—	−52 (−1)	−1,314	+42 (+4)	+4,930	−9	−1,500	—	—

Figures in parentheses denote number of machines. * Not including machine-tool cutting parts.

and Parts during December, 1957

Other Lathes		Milling Machines		Planing, Shaping and Slotting Machines		Presses and Sheet Metal-working Machines		Other Machines		Machine Tool Parts*		Total	
Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt.	Value £	Quantity. Cwt. and No.	Value £
284 (28)	13,940	597 (25)	40,796	367 (4)	12,940	1,163 (25)	34,929	3,120(105)	162,867	733	46,204	10,108(272)	466,038
100 (2)	2,750	—	—	—	—	10 (1)	358	18 (4)	797	21	1,980	492 (10)	19,027
—	—	669 (11)	34,500	—	—	—	—	78 (3)	7,512	95	7,942	1,091 (19)	65,018
1 (10)	174	492 (8)	27,778	10 (1)	804	223 (2)	5,875	19 (6)	3,516	197	26,494	3,370 (89)	242,035
—	—	1,705 (4)	84,793	19 (1)	3,027	1,150 (1)	48,960	1,580 (17)	143,714	1,475	156,427	6,838 (40)	500,957
1,335 (5)	22,877	595 (18)	25,189	58 (1)	1,328	292 (5)	6,659	243 (19)	12,789	128	9,457	4,571 (84)	146,812
1,720 (45)	39,741	4,058 (66)	213,056	454 (7)	18,099	2,838 (34)	96,781	5,058(154)	331,195	2,649	248,504	26,470(514)	1,439,887
—	—	—	—	—	—	—	—	—	+964	−14	−1,011	—	—
—	—	—	—	—	—	—	—	—	—	—	+55	—	—
—	—	—	—	—	—	—	—	—	—	—	−3	—	—
—	—	—	—	—	—	—	—	+28 (+3)	+11,810	—	+94	—	—
—	—	—	—	—	—	−5 (−1)	−300	—	—	—	+415	—	—

Figures in parentheses denote number of machines. * Not including machine tool cutting parts.

Personal

MR. J. F. GARDNER, of 7 Newlands Avenue, Melton Park, Gosforth, Newcastle-on-Tyne, has been appointed representative for Refractory Mouldings & Castings, Ltd., Pleasant Place, Kegworth, Nr. Derby, for the Northern Areas.

MR. R. L. PAICE, who has been sales director of Igranic Electric Co., Ltd., Bedford, since 1948, recently relinquished this position. Mr. A. W. PAGE, as sales manager, is now responsible for the home and export sales organization. Mr. Paice, as a director of the company, will carry out special assignments of the board.

MR. R. G. DE'ATH has been appointed group sales executive to Thos. P. Headland, Ltd., 10 Melon Road, Peckham, London, S.E.15, and subsidiary companies.

MR. R. E. BORTON has been appointed an additional outside sales representative for F. M. Parkin (Sheffield), Ltd., and will operate from their new office and warehouse at Chapel Street, off Booth Street, Handsworth, Birmingham, 22 (telephone number, Northern 9707). It is also announced that MR. A. E. PERCY, a brother of the company's permanent representative, Mr. W. J. Percy, has been appointed to the London office and warehouse at 6-9 Red Lion Market, Whitecross Street, Finsbury, E.C.1 (telephone number, Monarch 9102).

Machine Tool Share Market

Stock markets relapsed into idle conditions during the past week, and the general trend was for prices to drift to slightly lower levels. The gilt-edged section sustained moderate interest. After some firmness had been displayed, a sharp reactionary tendency developed, but the tone improved again towards the finish.

Activity in the commercial and industrial sections remained at a low level, and movements among prices generally were small and irregular.

Among machine tool issues, Brooke Tool lost 6d. at 5s.; John Harper, 4½d. at 13s. 6d.; Kayser Ellison, 6d. at 51s.; John Shaw & Sons (Wolverhampton), 1½d. at 11s. 6d.; and Thos. W. Ward, 3d. at 73s. 3d. On the other hand, Edgar Allen advanced 6d. to 28s. 6d.; British Oxygen, 2s. to 33s. 6d.; Clarkson Engineers, 6d. to 10s. 6d.; and Coventry Gauge & Tool, 6d. to 13s. 6d.

A. A. JONES & SHIPMAN, LTD. Second interim dividend of 30 per cent, making a total of 35 per cent for 1957.

COMPANY		Denom.	Middle Price
Abwood Machine Tools, Ltd.	Ord.	1/-	9d.
Armstrong, Stevens & Son, Ltd.	Ord.	5/-	7/9
Allen (Edgar) & Co., Ltd.	Ord.	£1	28/6
" " "	5% Prf.	£1	14/9*
Arnott & Harrison, Ltd.	Ord.	4/-	14/-
Asquith Machine Tool Corp., Ltd.	Ord.	5/-	18/9
" " "	6% Cum. Prf.	£1	17/9
Birmingham Small Arms Co., Ltd.	Ord.	£1	24/6
" " "	5% Cum. "A" Prf.	£1	15/-
" " "	6% Cum. "B" Prf.	£1	17/6
" " "	4% Ist. Mort. Deb.	Stk.	85/-
British Oxygen Co., Ltd.	Ord.	£1	33/6
" " "	6½% Cum. Prf.	£1	21/6
Brooke Tool Manufacturing Co., Ltd.	Ord.	5/-	5/-
Broom & Wade, Ltd.	Ord.	5/-	9/9
" " "	6% Cum. Prf.	£1	17/9xd
Brown (David) Corporation, Ltd.	5½% Cum. Prf.	£1	14/4½
Buck & Hickman, Ltd.	6% Cum. Prf.	£1	17/6
Butler Machine Tool Co., Ltd.	Ord.	5/-	6/3
" " "	5% Cum. Prf.	£1	13/9
C.V.A. Jigs, Moulds & Tools, Ltd.	5½% Red. Cum. Prf.	£1	13/9
Churchill (Charles) & Co., Ltd.	Ord.	2/-	4/6
" " "	6% Cum. Prf.	£1	26/3†
Churchill Machine Tool Co., Ltd.	Ord.	5/-	17/6
" " "	6% Cum. Prf.	£1	18/9
Clarkson (Engrs.), Ltd.	Ord.	5/-	10/6
Cohen (George), Son & Co., Ltd.	Ord.	5/-	11/-xd
" " "	4½% Cum. Prf.	£1	14/6xd
Coventry Gauge & Tool Co., Ltd.	Ord.	10/-	13/6
" " "	5% Cum. Red. Prf.	£1	16/3
Coventry Machine Tool Works, Ltd.	Ord.	4/-	9/-
Craven Bros. (Manchester), Ltd.	Ord.	5/-	6/-
Elliott (B.) & Co., Ltd.	Ord.	1/-	3/-
" "	4½% Red. Cum. Prf.	£1	13/9
Export Tool & Case Hardening Co., Ltd.	Ord.	2/-	1/6
Firth Brown Tools, Ltd.	4% Cum. Prf.	£1	12/-xd
Greenwood & Batley, Ltd.	Ord.	£1	46/10½
Harper (John) & Co., Ltd.	Ord.	5/-	13/6
" " "	4½% Red. Cum. Prf.	£1	12/7½
Herbert (Alfred), Ltd.	Ord.	£1	62/6xd
Holroyd (John) & Co., Ltd.	"A" Ord.	5/-	10/6
" " "	"B" Ord.	5/-	9/9
Jones (A. A.) & Shipman, Ltd.	Ord.	5/-	21/3
" " " "	7% Cum. Prf.	5/-	5/-
Kayser, Ellison & Co., Ltd.	Ord.	£1	51/-
" " "	6% Cum. Prf.	£1	18/3
Kendall & Gent, Ltd.	Ord.	5/-	7/9
Kerry's (Gt. Britain), Ltd.	Ord.	5/-	5/6
Kitchen & Wade, Ltd.	Ord.	4/-	10/3
Martin Bros. (Machinery), Ltd.	Ord.	2/-	2/4½
Massey, B. & S., Ltd.	Ord.	5/-	7/3
Modern Engineering Machine Tools, Ltd.	Ord.	5/-	10/-
Newall Engineering Co., Ltd.	Ord.	2/-	5/-
Newman Industries, Ltd.	Ord.	2/-	2/9
" " "	6% Prf. Ord.	5/-	5/6
Noble & Lund, Ltd.	Ord.	2/-	4/9
Osborn (Samuel) & Co., Ltd.	Ord.	5/-	16/3
" " "	5½% Cum. Prf.	£1	24/6xd
Pratt (F.) & Co., Ltd.	Ord.	5/-	20/-
Scottish Machine Tool Corporation, Ltd.	Ord.	4/-	5/3
Shardlow (Ambrose) & Co., Ltd.	Ord.	£1	33/6
Shaw (John) & Sons, Wolverhampton, Ltd.	Ord.	5/-	11/6
Sheffield Twist Drill & Steel Co., Ltd.	Ord.	4/-	35/-
" " " "	5% Cum. Prf.	£1	15/-
Stedall & Co., Ltd.	Ord.	5/-	4/9
Tap & Die Corporation, Ltd.	Ord.	5/-	7/9
" " " "	4½% Deb. 1961-1977	Stk.	82/-
Wadkin, Ltd.	Ord.	10/-	19/6
Ward (Thos. W.), Ltd.	Ord.	£1	73/3xd
" "	5% Cum. Ist. Prf.	£1	15/6
" "	5% Cum. 2nd Prf.	£1	24/6
Willson Lathes, Ltd.	Ord.	1/-	2/4½

The Middle Prices given in the list are in several cases nominal prices only and not actual dealing prices. Every effort is made to ensure accuracy, but no liability can be accepted for any error. * Sheffield price. † Birmingham price.